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STRENGTHENING THE ROYAL DRUGS RESEARCH LABORATORY

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NEPAL

Technical report: Evaluation of activities 1984-1988*

Prepared for the Government of Nepal
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Mr. Nithya Anand, UNIDO consultant

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* This document has not been edited.

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Summary

A. Outputs

The implementation of this project has resulted in overall strengthening and upgrading of the R & D capability of Royal Drugs Research Laboratory as also in specific hard R & D outputs.

1. R & D Strengthening

The more significant of the facilities created and strengthened by this project are:

- o A modern Pilot Plant Laboratory, having multipurpose units for processing of plants for preparation/production of variety of natural products
- o Animal House
- o Biological Screening Programme
- o Instrumentation Section
- o Glass Blowing Section
- o Economic Mapping Programme
- o Up grading of the Drug Quality Control Testing & Essential Oil Screening Programme.

2. Establishing coordination with agencies likely to use the outputs of RDRL, such as Herbs Production & Processing Laboratory, Royal Drugs Ltd. and Singh Durbar Vaidya Khana.

3. Reorganisation of RDRL to project based functioning of the R & D programmes.

4. R & D outputs.

a. Processes/products already transferred to industry.

- o Sugandhakokila essentiai oil
- o Lichen resinoids
- o Formulations
  - Deep Heat Cream
  - Anticold Antirheumatic Oil
  - Rhubarb Laxative

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b. Processes/products likely to be commercialised soon.

- o Acrus calamus essential oil
- o Diosgenin from Diascorea deltoidea
- o Eucalyptus (cineole type) essential oil
- o Sugandhakokila fixed oil
- o Modernised process for Shilajeet

c. Development of Pharmacognostic Standards for plants use in Ayurvedic drugs.

Vol. 1. Covering 20 plants, already issued
Vol. 2. Covering 20 plants, under print
Vol. 3. Covering 20 plants, manuscript ready.

d. Economic mapping of 94 economically important medicinal and aromatic plants in parts of 19 districts has been completed and 7 reports prepared. These reports have shown new sources for some economically important plents.

B. Perspective

- o Through this project unique nucleus & infra-structure base has been built at RDRL for R & D in the area of Drugs and Pharmaceuticals which can be used for achieving self-reliance in this area in Nepal.
- o The project has the right perspective & the programmes are moving in the right direction.
- o This is now the challenge to the senior staff of RDRL; to maintain the momentum and direction, to develop self-confidence and provide the leadership, because ultimately there is no substitute for local hard effort to develop self reliance; RDRL, however, will need financial support for some time to maintain the temps of work.
- o UNIDO, therefore, must not abruptly withdraw the support and should provide a phasing out grant for two years, of $ 125000 & $ 100000 respectively, for specified tasks/projects and very selective study tour & training programme which will give time for RDRL to develop links & other sources of funds.

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C. The instrumentation, and animal house facilities (and glass blowing facilities when fully operational) established at RDRL can serve as National facilities as these facilities would be needed by many institutions in Nepal and are not available in any other Institution. H.M.G. should consider this suggestion and draw up a suitable mechanism of doing this;

D. The Pilot Plant Laboratory would provide a unique facility for upscaling and semi-commercial production and should also be used as a National facility.

CONTENTS

1. INTRODUCTION

Nepal abounds in flora on account of the immense diversity of geographical terrains and climatic conditions available from hilly Alpine to Temperate and Sub-Tropical and even Tropical zones, and it is estimated that about 7000 species of higher plants are found in Nepal. Thus a large number of plants of established medicinal and aromatic value grew spontaneously in Nepal, and many plants of economic and medicinal value which do not grow spontaneously can be introduced and cultivated on account of the salubrious climate conditions offered by Nepal.

1.1 Background:

In Nepal, there is a very old tradition for the use of plants as medicines, both as a part of the Ayurvedic system and as folk remedies, and at a rough estimate about 80 % of the population uses these remedies, and it is likely to continue to do so for a long time to come.

A large majority of the population of Nepal (over 90 %) lives in rural areas and depends for its livelihood on agriculture, horticulture or forest produce. Nepal has traditionally been a great supplier of medicinal and aromatic plants. If these plants could be processed within Nepal it would greatly add to the economic status of the rural population, and also earn greater foreign exchange, and cutdown on import of finished products. Development and utilization of plants resources has thus a special relevance for Nepal. To promote this activity in the broadest sense HMG of Nepal set up the Department of Medicinal Plants as a part of the Ministry of Forests and Soil Conservation. The Royal Drug Research Laboratory (RDRL) is the major research laboratory of this Department of Medicinal Plants for carrying out developmental research on medicinal and aromatic plants.

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1.2 Research on Plants the Scientific and Economic Importance

Plants continue to occupy an important place in therapeutics inspite of the great increase in the number of synthetic drugs and drugs of microbial origin, and some of the reasons for this are discussed below:

a. Plants are the only economic sources for a number of important and essential drugs which include quinine, quinidine, morphine, codeine, papaverine, ergot alkaloids, digoxine, vincristine, vinblastine, atropine and related alkaloids, emetine, colchicine, sennosides, psylium mucopolysaccharide bulk laxative. In addition,plants are an important source of some important chemical intermediates needed for pro - duction, by relay synthesis, of some important drugs, such as diosgenin (for Dioscorea sp.) for contraceptive steroids and corticoids, tabersonine (from Vocanga africana and V. thourasii) for Vincamine and Catharanthine and Vindoline from Catharanthus roseus for anticancer dimeric indole alkaloids. At a rough estimate 25 % of the modern drugs would be, directly or indirectly, of natural products origin.

b. Most of the traditional remedies are prepared from plants, and usage of traditional remedies in Nepal, as in many other developing countries is very wide spread. Although exact figures are not available but it is estimated that over 80 % of the population in Nepal still depend upon these remedies. The relevance, role and place of remedies of traditional systems of medicine remains somewhat of a controversial issue. On the one hand we have the ardent supporters of the traditional medicines who claim that for every disease a remedy is available from traditional drugs; on the other the protagonists of modern medicine firmly believe that the usefulness of these remedies is grossly exaggerated. Both these views are extremes and the truth lies somewhere

in the middle. The fact that many of the remedies of traditional systems were a part of a system of medicine and were introduced through a distinct methodology, quite scientific in the context of the tools of the time when they were discovered, and have stood the test of centuries of use, makes them scientifically of much interest. Chemical investigation of traditional remedies in the last two centuries, when new tools for scientific investigation become available, provided many major drug discoveries, such as ephedrine, quinine, emetine, morphine, digitalis glycosides, reserpine and tubercurarine, thus fully validating the correctness of earlier usage, and more recently the antimalarial artemisinine and hypolipidemic gugulsterone have been added to this list. And there is no reason to believe that more such discoveries will not follow if research effort is continued. Further these drugs are a part of the socio-cultural millieu, and apart from the rural population who by and large perforce depend upon them, even in the most affluent parts of the society of these countries traditional remedies are used for common ailments. So why not make a scientific and rational use of this vast resource. This is the scientific aspect of the need for investigation of traditional remedies. As at least 80 % of the population of Nepal still uses them, their total turnover, although difficult to quantify, would in economic value be near to that of modern drugs. The preparation of these remedies requires large quantities of plants, cultivated or collected and drugs prepared locally which provide employment and economic benefit to a large number of local rural people. These are the economic dimension of this issue. So the scientific and economic aspects of the use of traditional remedies are important issue and cannot be over-looked.

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There is a growing appreciation of these issues by the countries using these remedies, by some of the developed countries and the International agencies, such as the W.H.O., and there is a greater focus now for making use of the traditional remedies in medicare programme, particularly for primary health care.

c. Investigation of plants and traditional remedies has led not only to the discovery of new drugs, but, what is more important, these structures in turn have provided useful leads for molecular modification for discovery of new drugs, and modern drug research has drawn heavily on such leads obtained from investigation of plants and traditional remedies; some of the well known examples in this context are the discovery of aspirin based on salicin, second generation of analgesics and narcotic antagonists based on morphine, antimalarial plasmochin on quinine, modern local anaesthetics on cocaine and more recently the antiasthmatic drug cromoglycate on khellin. A global screening programme initiated and coordinated by National Cancer Institute, N.I.H, Bethesda, U.S.A. has uncovered anticancer activity in a variety of entirely novel structures, which apart from the possibility of providing anticancer drugs, have provided new leads for prospective anti-cancer agents. These include camptothecin, elephantopin, maytensin and ellipticine. Plants continue to provide useful new drugs such as the new antimalarial artemisinine from Artmesia annua discovered by the Chinese scientists, which is active against the chloroquin resistant strains of Plasmodium falcinaram, and gugulipid discovered by the Indian scientists from resin of Commiphora mukul for hyperlipedemia.

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d. Plant constituents have also provided useful structures, which by chemical modification have led to drugs with improved or new biological activities, such as the anti-ulcer drug carbenoxolone obtained from glycyrrhetic acid and prolactin inhibitor bromocryptine from ergot alkaloids.

e. Plants are a renewable resource, and can be made abundantly available.

f. Concern with pollution caused by chemical industry makes phytochemical industry an attractive alternative.

g. The long term toxicity of drugs of synthetic origin, which most often bear no resemblance to natural products, and thus are not on the evolutionary pathway, may arise out of the inability of human body to handle/detoxify them. While drugs of natural origin would in general be capable of being handled by the human system and thus are likely to be less toxic, and particularly preferable to synthetic drugs, if found equally effective.

h. As most of the plants needed for manufacturing traditional remedies are commonly growing plants, and the manufacturing process is rather simple, drugs of traditional system are likely to be cheaper than modern drugs.

Plants thus provide a very useful resource material for:

(i) production of drugs/chemicals of accepted economic value;
(ii) discovery of new drugs;
(iii) production of drugs of traditional systems of medicine.

Viewed in this context the present project, whose primary purpose is to facilitate and promote the use of Nepalese plants and Nepal Traditional remedies, offers considerable scope and has both scientific and economic merit in it.

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The present project has as its main objective the strengthening the research and development capabilities of the RDRL, and was approved by UNDP/UNIDO in December 1981.

2. Objective of the Project

There is special importance and relevance in promoting the utilization of plant resources for economic & industrial development of Nepal and for strengthening of the R & D capability of Royal Drugs Research Laboratory as:

- A large number of plants of established industrial/ economic (particularly medicinal & aromatic) value grow spontaneously in Nepal or can be introduced and cultivated on account of the prevailing salubrious climatic conditions;
- There was practically no industrial productions of phytochemicals or modern medicinal products from these plants when the project was initiated;
- Ayurvedic drugs based mainly on plants are a part of the socio-cultural and health care traditions of Nepal & are still used by about 80 % of the local population;
- Royal Drug Research Laboratory of the Department of Medicinal Plants of the Ministry of Forests & Soil Conservation was established for carrying out developmental research on medicinal & aromatic plants with the following main aims and objectives:

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a. Promotion of drug research; (b) development of technology for production of plant products; (c) developing standards & carrying out quality control of drugs and allied materials for Department of Drug Administration (DDA) of Nepal; (d) providing technical guidance for establishing drug industries in Nepal; (e) helping in the better utilization of Ayurvedic drugs.

In view of the central position occupied by RDRL in the development and transfer of technology for production of plant products in Nepal and in keeping with the UNIDO's objectives of promoting the utilization of plant resources and helping industrial production; UNIDO approved this project principally for institutional strengthening of RDRL to enhance its R & D capability to:

1. promoting industrial production in Nepal by developing technology for products of established economic value based on plants available by spontaneous growth and or by cultivation;

2. promoting the utilization of Ayurvedic Drugs;

3. developing drugs to be used in modern medicine from Ayurvedic drugs or plants growing in the wild in Nepal;

4. strengthening the quality control testing capability;

The immediate project objectives were:

1. Enhancing R & D and pilot plant production capability of RDRL for processing of plants;

2. Developing production technology for products of established economic value based on plants available from the wild or by cultivation;

3. Developing quality control standards for Ayurvedic drugs particularly for those that are used in the primary health care programmes. This will include developing procedures for quality control and modernising methods of production where possible;

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4. Developing formulations based on Ayurvedic drugs for use in modern therapeutics;

5. Screening of plants growing in Nepal for essential oil content.

6. Carrying out biological screening of plants collected from different parts of Nepal for development of new drugs;

7. Strengthen the Royal Drug Research Laboratory to serve more effectively as the public analyst laboratory for herbs and related products & for quality control testing for Drug Administration in Nepal.

8. Carrying out economic mapping of plants of established economic value and to establish core of trained staff who could continue this work on a long term basis;

9. Establish organic linkages for greater co-ordination of activities of RDRL and other institutions which rely on its outputs.

3. Outputs

A. Institutional Strengthening of RDRL

A.1. R & D Capability Strengthening

There has been a considerable overall strengthening and upgrading of the R & D capability of the Roval Drugs Research Laboratory as a result of the implementation of this project (Annex - 1 & 2).

Among the specific objectives set to be achieved as a result of this strengthening RDRL, the progress has been as follow:

a. The drugs and essential oils quality control testing capability of the RDRL has been considerably enhanced, and it is now serving more effectively as a Public Analyst Laboratory for herbs, drugs and related products and as the

Drug Testing Laboratory for the Department of Drug Administration;

b. The analytical and phytochemical facilities in RDRL are now at an advanced level, and analysis & isolation of chemical constituents of essential oils or of other plant constituents can be and is routinely carried out;

c. A good nucleus of an animal house has been established; it will, however, need further expansion to provide adequate number of animals for biological screening;

d. A good start has been made in establishing primary biological screening procedures for new drug development, certain strengthening in staff and expertise in pharmacological testing and preclinical toxicological evaluation would be needed;

e. The economic mapping is well under way; although it is a long term endeavour and needs to be completed with patience and preserverance, but what is important is that a good core staff has been trained in this activity and would be able to carry out this work on a continuing basis;

f. The pilot plant at Godavari is now completely installed and provides excellent multipurpose unit processing facilities not only for processing of medicinal & aromatic plants but also for some simple organic synthesis operations; the operations have shown some shortcomings in design of some of the pieces of equipment as pointed out by the Expert of Process Technology (Annex 4) and need to be rectified;

g. The laboratory now has the nucleus of a Glass Blowing Section which will get fully operational when the equipment which is on order, arrives; the expert is proposed to be fielded after the rest of the equipment is received;

h. The laboratory now has also nucleus of an Instruments Maintenance Section with technicians trained abroad as also with the expert fielded for on-the-spot training.

A.2 Inter-institutional Co-ordination

As one of the outputs of this project is the development of appropriate technologies for the indigenous production of industrial products based on Nepal's existing and potential resources of medicinal & aromatic plants, Joint Co-ordination Committees have been formed and Herb Production & Processing Co. Ltd. (HPPCL), Royal Drugs Ltd. (RDL) and Singh Durbar Vaidya Khana (SDVK) as these organisations are likely to undertake industrial productions based on technologies developed by RDRL (RDRL's output would be their input). This should lead to joint identification of the projects, and mutual consultation and monitoring of the progress, which would lead to better utilisation of R & D outputs. For each specific task, separate Task Force Committees have been formed with a Convener, who would convene the meetings and keep record of all the meetings and monitor the progress. It was decided that the JCC's would meet every 2nd month and the proceedings of each meeting would be minuted and circulated to the members for follow-up action which the Task Force Committees would meet more frequently. A record of Joint Co-ordination Committee meetings held is given as Annex - 5.

A.3 Project Based Operation of R & D Work of RDRL

With a view to sharpen the multidesciplinary focus of R & D work, to make optimal use of the available resources and scientific staff and to time-schedule the work, project based working has been introduced for RDRL research & development work. There are about twenty on-going projects in the laboratory at the present and all the scientific & technical staff is allotted to one or more of these projects. Each project has a Task Force, drawing in scientists from different desciplines with a Convener. The Task Forces are required to meet at least once a month to review & monitor the progress

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of work and plan future work. All the project group conveners form the Project Evaluation Cell with D-G as the Chairman which meets at frequent intervals to review and monitor the entire work of RDRL, and also to approve any new project to be started.

A.4 Scientific Seminars & Lectures

One measure of the scientific vitality and strength of a research laboratory is the frequency at which scientific meetings and seminars are held. RDRL has now a regular Lectures and Seminars programme which helps to keep the scientists excited & abreast of recent developments and the various seminars & lectures held are given in Annex - 8.

A.5 Ph.D. Programme

RDRL and its associated institutions are amongst the best staffed and equipped laboratories in Nepal and could serve as centres for post-graduate training. It is hoped that Tribhuvan University (T.U.) will recognise RDRL as a centre for post-graduate research and for senior staff of RDRL to act as supervisors. This will greatly add to the scientific strength of RDRL; a student population always add to the vigour and dynamism of a laboratory. T.U. will benefit by its students getting good post-graduate training in a well equipped laboratory. A formalised academic relation between T.U. and DMP/HMG will greatly enhance the post-graduate training facilities in Nepal.

B. R & D OUTPUTS

Project No.1 To develop process technology on pilot scale for production of diosgenin from Dioscorea deltoidea.

1.1 Background:

Dioscorea deltoidea, known in Nepali as Vyakur, is a climber belonging to the family Dioscoreaceae. It is distributed between 900M - 3000M throughout Nepal. These tubers are valuable source for the production of diosgenin which is the raw material for production of many steroidal drugs such as corticosteroids, sex hormones etc. With a view to initiate the establishment of an indigenous steroid industry, the production of diosgenin seemed a very useful starting point. Survey analysis of dioscorea tubers harvested from different localities showed the diosgenin content varied from below 1 % to above 7 % depending upon the age and localities of collection of the tubers. The availabilities of the tubers could not be assessed conclusively.

Work was also conducted on the conversion of diosgenin to various steroid drug intermediates. It was possible to convert diosgenin to 16 - DPA on a scale of 100 gms diosgenin with a yield of about 50 %. Similarly conversion of 16 - DPA to DHA has also been carried on a laboratory scale. Upscaling will be carried out subject to the availability of large quantity of diosgenin.

1.2 Objectives

Development of process for production of diosgenin from D. deltoidea tubers.

On the above context, it was considered necessary to develop the complete technology for extraction of diosgenin from dioscorea tubers and trasfer it to an entrepreneur for its potential industrial exploitation. The diosgenin that would be produced can either be used in home steroids industry or exported.

1.3 Work done

Optimisation studies of the two steps in isolation of diosgenin from the tubers, viz. (A) acid hydrolysis of the plant material and (B) solvent extraction of the hydrolysed plant materials were carried out.

A. Hydrolysis.

The plant material was first soaked overnight in water and disintegrated. This was boiled under reflux with 10 times (w/v) of 2.5 N sulphuric acid for two and half hours in 15 kg batch size in a haste alloy reactor. The time of hydrolysis and the ratio of acid was determined earlier by bench scale study. The ratio was successfully cut down to 1.5. Four batches were conducted using 30 kg of tubers. The yield of the hydrolysed mass was 30-35 % containing 8.5-10 % diosgenin starting from a plant material containing 2.7 to 3.5 % diosgenin.

Recycling of the acid remaining in the filtrate after hydrolysis was also investigated. Analysis showed it to be 50 % weaker than the starting concentration. This was made up by addition of fresh acid. This could be done for 3 cycles when the filtrate became too dark. This contained many impurities which affected the ultimate purity of the product. In view of this and the fact that the acid contributes a relatively small percentage to the total cost of the product it was considered better to use fresh acid for each batch.

Fabrication of Haste alloy or glass lined reactor can be quite expensive, so the posibility of using open wooden vat for hydrolysis was considered. One another problem is the filtration and freeing the hydrolysed product from adhering acid. There is a high loss of plant material as fine particles and choking of the filter bag during that operation. Hydrolysis study on 100 - 150 kg batch is being tried on newly constructed wooden vat of 1500 litres capacity with 7-8 % sulphuric acid for 3-4 hours. The effect of using the plant material as large as 25 mm without prior disintegration is being tried. This work is in progress.

B. Solvent extraction

The commonly used solvent in this extraction is benzene or hexane. Extraction with n-hexane carried out in the Haste alloy reactor and S.S. Concentrator at Thapathali resulted in a high loss of the solvent. In view of the difficulty of obtaining hexane or benzene in Nepal, use of alternate solvents is considered necessary. A comparative study was conducted using 1 kg hydrolysed mass with the following solvents: (1) Petroleum ether, 60-80^{o}c (2) toluene (3) xylene and (4) ethyl alcohol. It was found that ethyl alcohol has the high dissolution power but brings out many other substances along with diosgenin and that petroleum ether is the least powerful solvent but brings out the least amount of unwanted substances.

A detailed comparative study was conducted with ethyl alcohol and petroleum ether on 250g (hydrolysed materials) acale. It was found that it is possible to purify the crude diosgenin obtained from alcohol by recrystallization from dichloromethane and ethanol to obtain a sample of 90 % purity (c.f.92 % from petroleum ether extract) with a recovery of 5.3 % (c.f.4.9 % from petroleum ether extract).

Table

1 kg batch of Hydrolysed Drug.

Batch No	Batch size	Solvent used	Volume of Solvents Litres	Volume of Recovered Solvent Litres	Dried Powder Diosgenin % of the hydrolysed mass
1.	1 kg	Petroleum Ether ($60-80^{O}$)	15	9	5.18
2.	1 kg	Toluene	14	9	5.81
3.	1 kg	Xylene	13	9	4.68
4.	1 kg	Ethyl Alcohol	17	11	6.55

1.4 Conclusion:

Hydrolysis.

Problem in crushing of crude drugs and filtration of the crushed hydrolyed drug which resulted in loss of fine hydrolysed drug and clogging the filter cloth in its filtration. This is being overcome by hydrolysing precut (about 25mm size) and dried tubers directly with acid. One experiment of 100 kg gave satisfactory result. Work is continued for optimization of hydrolysis.

Extraction.

The results of the study show that ethyl alcohol is a good solvent for extraction of diosgenin from the hydrolysed drug. An appreciable quantity of the solvent will remain in the marc. Recovery of the solvent would be done by flushing the marc with live steam. This would result in loss of an appreciable quantity of dilute alcohol. A study will be conducted to find out the cost of recovery of solvents and its rectification and purification of crude diosgenin.

1.5 Future work

A. Continuation of ongoing hydrolysis studies of dioscorea tubers in open wooden vat in 100-150 kgs batch size will be continued to optimise the acid concentration and time of reaction and other parameters. The same is under progress.

B. Further comparative work on extraction of the hydrolysed plant material using n-hexane and ethyl alcohol on Pilot plant scale. This would also include study on rectification cost of dilute alcohol. Modification of the existing versatile extraction unit acquired under the project to suit rectification has been initiated.

Team member

1. A.D. Shrestha
2. Dr. K.R. Amatya
3. K.R. Prasad
4. Padma Prajapati
5. D.N. Jha
6. M.B. Narasima

Project No.2 To develop process for production of Belladonna extract containing 3 % alkaloids

2.1 Background

Belladonna is well established medicinal plant with good economic value. Although not indigenous to Nepal, it can grow well in more parts of the country. Its cultivation has been extended to the farmers' level by the joint efforts of the Department of Medicinal Plants and M/S. Herbs Production and Processing Co. Ltd. (HPPCL). The present produce of the farmers is processed to supply liquid extract to M/S. Royal Drugs Ltd. and also exported in crude form. There is a possibility to expand the cultivation of the crop and value added product can be made by standardising the extract to a known & high alkaloid content. The present project has been initiated with the development objective of obtaining extract of 3 % and 6 % alkaloid content belladonna leaves, which have a ready international market.

2.2 Objective:

Development of a process for belladonna extract from belladonna leave containing 3 % and 6 % total alkaloids.

2.3 Outputs

A preparation containing 3 % total alkaloids has been prepared on the bench scale followed later on the pilot plant scale. A sample was supplied to HPPCL for market evaluation. It was reported back by HPPCL that the product though stable in the laboratory deteriorated in the trade.

On the suggestion of HPPCL, processes for products containing higher percentage of alkaloid have been developed, which are likely to be more stable; two products have been prepared which contain 70% and 90% total alkaloids. The recovery, yield, alkaloids content and stability have been

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standardised in the laboratory scale. The processes are going to be studied on the pilot plant scale in the near future.

Future work

Process for belladonna extracts containing 3 %, 70 % & 90 % total alkaloid have been standardised on a laboratory scale. The market acceptability of these products as also the production on pilot plant scale and extended stability will now be studied.

Project No. 3: To develop a process for the production of resinoids and absolute from Lichens

3.1 Background

About 400 different species of lichens grow in the wild in Nepal. Some of the lichens are of great economic value as food, fodder, dyestuffs, perfumery materials and for tanning. It is estimated that over 1000 tons of dried lichens can be harvested annually from 55 districts out of a total 75 districts of Nepal. A substantial amount of the lichens are exported in the crude form.

3.1 Objectives:

It was considered important to develop technically viable method for the production of resinoids and absolute based on the Nepalese lichens (such as from Parmelia nepalensis) and carry out a market survey for its accessibility in perfumery industry.

Tasks

1. Identification of lichens occuring in Nepal.
2. Selection of suitable process for extraction.
3. Development of Chromatographic and analytical method for assessing the quality of the extract.

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4. Development of suitable method for the preparation of odourless alcohol used in the preparation of absolutes.

3.3 Outputs

1. About 25 different lichen species occurring in Nepal have been botanically identified and preserved in the Herbarium at Godavari.

2. Identification of the various species present in the market sample of lichens was carried out. Of the components identified Parmelia nepalensis constitute 70% of total. Remaining 30 % consisted of Parmelia nigherensis, Usnea thonsonii, Ramalina subcomplanta, Usnea sps.

3. Normally hydrocarbon solvents are used for the extraction of resinoids from lichens. In Nepal hydrocarbon solvents are expensive as compared to ethyl alcohol. Therefore a comparative study was made using ethyl alcohol, n-hexane, benzene, toulene, petroleum ether (40 - 60°c) as extracting solvent.

Extraction methods involved: (a) cold percolation; (b) reflux and (c) soxhlet extraction. A preliminary evaluation of the extract was carried out, based on their yield, colour, consistency and odour. Lichens extracted with hydrocarbon solvents yielded between 1.0 to 2.87 percent resinoid, whose colour varied from white, yellowish to light green. While the colour of the benzene extract was acceptable, the odour, however, was not of the required quality. The alcoholic extract of lichen yielded between 3 - 19% of resinoid with acceptable odour and consistency and dark brownish in colour. The odour assessment was kindly carried out by Dr. G.D. Kelkar of M/S. S.H. Kelkar and Company, Bombay. The products obtained by different extraction procedures have also been evaluated by HPPCL. Taking an overall balance of yield, colour and odour the product obtained by ethanol extraction seems to have the best commercial prospects.

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HPPCL, therefore, has adopted the alcoholic extraction method and the product is sold in the international market.

4. A thin layer chromatography (T.L.C.) method of analysis of the resinoid extract was developed. The method was employed to check the quality of commercial extract produced by HPPCL. TLC profile of the standard extract prepared in the laboratory and that of commercial extract are found identical. The method is useful to control the quality of different batches of commercial extract of lichens.

5. In order to develop a suitable method for the preparation of absolutes from lichen extract odourless alcohol is required. Amongst the different methods tried, the following method yielded an alcohol sample of acceptable odour: A mixture of rectified spirit and water is distilled. The middle portion distillate is treated with lead acetate and potassium hydroxide and the alcohol is decanted followed by redistillation. The alcohol thus obtained has light alcoholic odour with pungency much reduced.

Conclusion

A method of extraction of resinoids of lichens has been worked at the laboratory scale. A chromatographic method for quality control of lichen extract has been developed. HPPCL has commenced extracting lichens and a new product "LICHEN RESINOIDS" has been successfully launched in the international market.

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Project No. 4: To produce pine needle oil from Abies species

4.1 Background

Pine trees are widely distributed in Nepal and as forest product constitute one of the important natural resources of the country. Pine tree produces abundant leaves which on distillation yield pine needle oil. This oil has commercial value. In order to utilise this natural resource a programme to investigate the pine species of Nepal as a commercial source of pine needle oil was initiated. The following gives a brief account of this work.

4.2 Objective

a. To investigate various pine species of Nepal as a commercial source of pine needle oil.

b. To develop a method for production of export grade pine needle oil from pine needles.

4.3 Methodology

a. To collect pine needle of right species

b. To distill the plant materials in laboratory scale and to determine the quality.

c. To distill the plant material in pilot plant.

d. To evaluate the techno-economic feasibility of the oil.

4.4 Progress of the work

The following pine species have been identified as of potential economic value for processing.

a. Abies pindrow

b. Abies spectabilis

c. Pinus wallichii

d. Pinus roxburghii

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e. Picea smithiana

f. Cedrus deodara

The relative abundance of these is described in the report of project No. 20 dealing with economic mapping. All of the above pine species are found growing wild in Western Nepal. But the first four are distributed in other parts of the country also.

4.4.1 Chemical investigation

Pine needles and cones of Abies spectabalis have so far been investigated. These were collected from Rasuwa and Dolakha districts. Oil content of the needles varied between 0.22 - 0.48 %. The chemical constituents of the oil are tentatively identified as α-pinene, β-pinene, camphene, limonene and bornyl acetate by using GC and TLC methods. Bornyl acetate, the major constituent in the Dolakha sample, was isolated and its identity confirmed by comparing its IR, TLC, and GC with authentic bornyl acetate.

4.5 Future work plan

Investigation on pine needles collected from various parts of the country will be continued. On the basis of the work carried out at RDRL a commercial scale distillation of pine needle oil at a suitable location will be recommended.

.../...

Project No. 5: Production of fixed oil from Sugandha Kokila spent berries

5.1 Background

Sugand Kokila berries, on distillation yield a volatile oil which has been developed into an industrial product. The spent berries of Sugandha Kokila left after the volatile oil distillation have been investigated for possible production of by-products which will add to the profitability of the project. Laboratory examination indicated that the berries are rich in fixed oil which may find some application. Keeping this factor in mind further investigation of the oil was made and the results obtained during this study are briefly described below.

5.2 Objective

To standardise a process for production of the fixed oil from spent berries of Sugandha Kokila.

To explore possible uses of the fixed oil of Sugandha-kokila berries.

5.3 Study of fixed oil of berries

Sugandhakokila fruits consists of two parts: Pericarp 6 % and seed 39 %. The petroleum ether (48^{o}- 80^{o}C) extract of the pericarp yielded a concrete (23 %) while that of seed yielded fixed oil (48.5 %). On the other hand, the yield of the concrete and fixed oil from spent berries were 17.5 and 52 - 62 % respectively. The yield of fixed oil, however, depends on size of the seeds and the solvent used.

Investigation to determine the chemical constituents of the Sugandha kokila fat was undertaken. The almost solid nature of the fat obtained influenced to compare its chemical constituents with the sal seed fat which has industrial

.../...

application mainly due to its semi-solid characteristic at room temperature (such as substitute for coco butter). A comparision of physico-chemical constants and chemical constituents between the Sugandhakokila seed fat and sal seed fat was made. The result of this comparision led us to draw the following conclusions:

a. Sugandhakokila fat is more saturated (iodine value: 9.8) than sal seed fat (iodine value: 37.45). The saturated fatty acid content of sal seed fat is about 46 % whereas that of Sugandha kokila fat is about 95 %.

b. Unlike sal fat the Sugandhakokila fat is made up of capric (11.4%), lauric (79%) myristic (2.5 %) and palmitic (1.95 %) while the four major acids of sal seed fat are oleic (41.9 %), stearic (37.7 %), palmitic (8.3 %) and linoleic (2.8%).

c. A close examination of the chemical constituents of Sugandhakokila fat suggests that it resembles more with coconut fat so far as the major constituents are concerned.

5.4 Toxicity Test

Some exploratory toxicity studies on the fixed oil have been carried out which are as follows:

a. In skin irritation test carried out in rabbits accerding to standard methods no adverse effect was observed.

b. Acute toxicity was carried out in mice. In this test it was observed that no animal died up to a dose of 10 ml/kg of oil up to a period of 4 weeks. No significant gross observational changes were observed during this period.

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5.5 Conclusions

a. The fat consists of high percentage of lauric acid, and appears to be a good source for this industrially important chemical.

b. The fat may find uses in textile, soap, cosmetic, food plasticisers and pharmaceutical industries.

Project No. 6: a. Production of high quality Rosin and Turpentine
b. Production of Pine oil from Turpentine

6.1 Background

Rosin and Turpentine also known as naval stores is an important forest product. There are already two factories in Nepal, one large one with an annual capacity of processing 4000 tons of gum oleoresin located in Kailali District, Far Western Development Region and one smaller one with an annual capacity of 200 tons situated in Bara District, Central Development Region, A third one of large size is being planned in Banke District, Mid Western Development Region. It is estimated that 18,000 tons of gum oleoresin can be produced annually by tapping the existing chirpine (Pinus roxhurghhi) forest (Ref. Department of Forest). These figures indicate the high potentiality of Rosin & turpentine industry and industries based on its downstreem products.

The project is intended to provide R & D support to the Rosin and Turpentine industry of the country. At the time of the initiation of the project the distillation factory at Kailali was being established with the assistance of the USSR. This factory is now under operation under the organisation named Nepal Rosin and Turpentine Ltd. (NRTL) and the smaller scale factory of HPPCL at Bara District is processing

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about 100 tons of gum oleoresin annually. As an R & D support to these industries preparation of quality control standards, improvement of the quality of products, development of process for derivatives and other downstream products from rosin and turpentine were considered to be essential.

6.2 Objective

a. Production of pine oil from turpentine.

b. Preparation of quality control standards for rosin

c. Production of high quality rosin.

d. Preparation of derivatives of rosin.

e. Preparation of derivatives & downstreem products from turpentine.

6.3 Outputs produced and problems encountered

a. Production of Pine oil from Turpentine

A process was developed for the production of pine oil from turpentine containing about 28 % total pinenes, using aqueous sulphuric acid and acetone on 500 ml turpentine scale. The terpineol content as determined by g.l.c. and B.S.I. method (chemical) was about 20%. The quality was considered satisfactory by HPPCL.

However, in view of the high cost of acetone & its fire hazard, development of a process avoiding the use of organic solvent is under progress. Use of a surfactant is also being tested.

b. Preparation of quality control standards for rosin

c. and production of high quality rosin.

Bench scale studies on improvement of the quality of rosin were conducted using orthophosphoric and oxalic acids for removal of iron in the oleoresin before distillation.

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Different characters (physical and chemical properties) of rosin such as acid number, unsaponifiable matters, colour opades, softening points, insoluble matter etc. were studied for fixing standards and grading. Several samples of rosin were submitted to HPPCL for assessment. They have approved two of them. However, NRTL factory has now come into operation. It uses modern technology for producing rosin of internationally accepted standards. Considering thus this activity has been dropped for the time being. Nepal Bureau of Standards (N.B.S) has a programme to prepare standards for rosin in the near future. The three organisations: N.B.S., NRTL and RDRL shall be involved in fixing a practical and acceptable standard for rosin.

d. Fractional Distillation of Turpentine

This study was taken up to gain some experience in isolation of the components of Nepalese turpentine for subsequent use in preparation of downstream products. The study was undertaken on 250 ml scale and subsequently on 5 l. scale. It has been possible to obtain fractions containing 85 % alpha pinene and fractions containing over 95% carene starting from turpentine containing 12 % alpha pinene and 60 % 3-carene using 1:10 reflux ratio.

e. Preparation of derivatives of Rosin

(i) Adducts of Rosin: Among the several derivatives of rosin fumaric adduct was considered first. A preliminary survey of its demand in the Indian market was carried out. This indicated that the demand for this product was not so high. The work was switched over to maleic and phenol-formaldehyde adducts. The work on the former is making good progress. A chromatographic method for monitoring the progress of the reaction is being studied. Parameters for the reaction is being standardised. A further work of about two months should be adequate for taking up pilot plant scale studies. Pilot plant study shall require a reaction vessel which can attain 160 - 190^{o}C.

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(ii) Esters of rosin as well as its adducts and other derivates such as hydrogenated, disproportionated etc. are in demand for paints and printing ink industries. To start with esters of raw rosin has been taken up. An ir spectroscopic method for monitoring the progress of the reaction has been developed. The products have been tested according to I.S.S.. Process for producing glycerol ester of raw rosin has been standardised in bench scale. Two more months on bench scale should be adequate for the penterythritol ester.

Fabrication of a reaction vessel for reaction in the range of 300^{o}C under inert atmosphere is required for pilot plant study. The possibility of conversion of a 250 l. s.s. reaction vessel possessed by RDRL for the purpose is being explored.

d. Derivatives and downstream products from turpentine

Possibility of development of processes for useful compounds besides pine oil (terpineols) was explored. Hydroxymethyl carene and its acetate were prepared. These compounds, however, do not have demand in the market. "Carene acetate" is an well established perfumary item. Methods for its production is being searched in the literature.

6.4 Linkage between RDRL and NRTL

RDRL has been able to develop a good rapport with the main producer of rosin and turpentine in the country, NRTL. The R & D work is going to be formally sponsored by NRTL. A proposal has been submitted to it and is awaiting approval and formal signing of agreement between NRTL & RDRL. The processes developed shall be transferred to NRTL.

6.5 Constraints and their solution

a. Nonavailability of proper reference material has been a major constraint. It is necessary to acquire reference materials in the field of paints, varnish and related materials in which the derivatives of rosin are used.

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b. The workers of RDRL, who are at present working in this field lack any exposition with related work in other countries. It is suggested that they are given short and long term training, sent on study visits to institutions and industries of related field in other countries.

c. A process technologist is required to be attached with the project so that he can identify the parameters of various processess that are required to be determined at the development in bench scale stage and for design of pilot plant and finally of manufacturing unit.

d. Laboratory equipments and instruments specially g.l.c. and accessories for HPLC should be consolidated. The glass blowing capability is inadequate at present to the requirement of the work and needs reviewing.

e. Market survey and nonavailability of standard samples has been a serious drawback in the progress of the project.

f. In view of the work that has to be completed within a fixed time the manpower available has been inadequate. It is suggested that it is strengthened so that the work required can be completed to meet the requirement of the client industry (NRTL).

6.6 Future Programme

a. Completing of the ongoing process development activity of pine oil and terpineol without the use of organic solvents.

b. Completion of process development for fractional distillation of turpentine for production fo α-pinene, β-pinene, 3-carene and other components.

c. Pilot plant studies on production of glycerol and penterythritol esters of Rosin.

d. Pilot plant studies on production of maleic adduct of rosin.

e. Process development of other rosin derivatives.

.../...

f. Process development of carene acetate and other useful perfumary compounds from carene, pinene and other compounds of turpentine.

g. Polymers from turpentine.

h. New derivatives & downstream products from rosin.

i. Alkyd resins.

Team Members

Dr. K.R. Amatya

Mr. B.R. Shakya

Mr. P.M. Shrestha

Mr. Y.N. Sukla

Mrs. Ramila Joshi

Mr. A.D. Shrestha

Mr. Radha Raman

Mr. Nabin Shrestha

Project No.7: Production of standardised total alkaloids of Rauwolfia serpentina

7.1 Background

Rauwolfia drug is the dried root of Rauwolfia serpentina (Linn) Bentham ex kurz. (Fam. Apocyanaceae), sometimes having fragments of rhizomes and aerial stem based attached. It contains not less than 0.15 % of reserpine-rescinamine group alkaloids, calculated as reserpine.

The plant is distributed in Nepalgunj, Bheri, Chhepatar, Letang, Tarahara, Mayakhola and Baguwa at an altitude of 180 m to 760 m. It is also cultivated in the herbal farms of the Department of Medicinal Plants in an experimental basis. Now the herbal farms are extending its cultivation extention programme in the farmers level.

Rauwolfia serpentina root is used mainly as an antihypertensive and as a tranquillizer. Royal Drugs Ltd. has shown interest in the production of preparations containing Rauwolfia to introduce in the market.

7.2 Objective

Royal Drugs Ltd. has a programme for the production of tablets of total alkaloids of Rauwolfia containing 0.1 mg of reserpine per tablet. Hence this project was undertaken as per the recommendation of the joint coordination committee to develop technology for extraction, formulation and to work out the quality control method of the products.

7.3 Methodology

Laboratory scale works in Rauwolfia serpentina was carried out by percolating the powdered drug in 90 % alcohol. The percolate was contentrated by means of a rotavapour. Analytical reports and yields of the extract are mentioned below.

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Batch size in the laboratory scale was 500 gms and the yield of the extract was about 50 gms.

Total alkaloid content in the crude drug = 0.835 percent.

Reserpine like alkaloids content in the crude drug = 0.0293 percent.

Total alkaloid content in the extract = 8.4629 percent.

Reserpine like alkaloids content in the extract = 2.0894 percent.

Pilot scale operation in 20 kg batch size was carried out at Thapathali fascilities by percolating the powdered drug with 90 % alcohol. The percolate was concentrated under vacuum concentrator below 60°C. The yield of the extract was 3 kg containing 6.559 % total alkaloids and 1.887 % of reserpine like alkaloids.

600 gms of the extract was supplied to Royal Drugs Limited for its approval. About 5000 tablets containing 2 mg of total alkaloids in each tablet were prepared and about 3000 tablets were supplied to Royal Drugs Ltd. for approval.

As per discussions with Royal Drugs Ltd. preparations of Rauwolfia tablets containing 0.1 mg of reserpine like alkaloids is desirable. Hence this preparation is in process.

7.4 Future Programme

1. Standardisation of Pilot scale operation to prepare extract at Godawari Pilot Plant facilities using versatile extraction units.

2. Preparation of Rauwolfia tablets containing 0.1 mg of reserpine like alkaloids in each tablet and supply to Royal Drugs Limited for approval.

3. Development of analytical method for the assay of reserpine like alkaloids in the extract.

7.5 Team Members

1. Mr. A.D. Shrestha
2. Mr. R.C.M.S. Rajbhanshi
3. Mr. T.R. Shakya
4. Mr. L.K. Vaidya.

Project No. 8 Production of slandardised total extract of triphala.

1.1 Background

Triphala is one of the most important drug of the Ayurvedic system. It is a mixture of equal parts of three raw drugs: Terminalia belerica (barro), Terminalia chebula (harro) and Embilica officinalis (amla). As it is a mixture of raw drugs it provides problems in dispensing. With a view to develop a more convenient and suitable formulations, the preparation of a standardised Triphala extract was undertaken at the instance of Royal Drugs Ltd.

1.2 Objectives:-

Production of standardised triphala extract.

1.3 Methodology:-

Alcoholic extract:-

Alcoholic extract of each of Terminalia belerica, Terminalia chedula and Emblica officinalis were determined separately. 50g of each of the powdered fruits of these drugs were extracted separately with 50 ml of 90 % alcohol by percolation. The yield of alcoholic extract was as follows:-

Terminalia belerica	- 0.52 %
Terminalia chedula	- 0.38 %
Embilica officinalis	- 0.31 %

Water extract of each of these drugs were determined as follows:-

Dried fruits of Terminalia belerica, Terminalia chedula and Embilica officinalis were powdered and 50 g of each of these powder was extracted separately with 50ml of distilled water by percolation. The water extract was concentrated under reduced pressure at 40°C to a thick syrup and was further dried in a vacuum desciccator over calcium chloride, The yield of water extract was:-

Terminalia belerica	- 5.31 %
Terminalia chedula	- 4.82 %
Embilica officinalis	- 5.96 %

1.4 Preparation of Triphala:-

50 g of each of the powdered dried fruits of Terminalia belerica, Terminalia chebula and Embilica officinalis were mixed together and extracted with distilled water by percolation. The extract was concentrated under reduced pressure at 40°C to a thick syrup and was further dried in a vacuum descicator over calcum chloride. The yield of triphala water extract was 21.1 % .

The extract was found to be very hygroscopic. It has so far not been possible to prepare a desirable formulation from it which could be easily handled.

1.5 Conclusion:-

In view of the interest shown by Royal Drugs Ltd this project was undertaken . But due to the hygroscopic nature of the product, Royal Drugs Ltd. did not want to pursue the project. It was decided to terminate this project.

Team members:-

Mr. A.D. Shrestha
Dr. Amriteswori Rajbhandary
Mr. T.R. Shakya
Mr Dhirananda Jha.

Project No. 9 Processing of Crude Shilajeet for Ayurvedic use.

9.1 Background

Shilajeet is one of the most important & presteqeous Ayurvedic drug. It is used for many diseases such as hypertension, diabetes, geneto-urinary infections, jaundice. According to Charaka, the great practitioner of Ayurvedic system of medicine: " There is hardly any curable disease which can not be controlled or cured with the aid of Shilajeet". Shilajeet which is an exudate on mountaneous rocks of Himalayan region is an exportable item of Nepal. A small amount of Shilajeet is processed by Singha Durbar Vaidya Khana (SDVK) and other Ayurvedic drug companies of Nepal. These companies employ traditional technologies to process crude Shilajeet into refined " Soft" Shilajeet and the period of processing varies from 40 days to 4 months. In view of long processing period SDVK sought technical help from RDRL to simplify the process and cut down the cost and time. The present study aims to workout suitable methodology for processing of Shilajeet.

9.2 Objective

a. To improve the method of production of processed Shilajeet.

b. To develop method for quality control of Shilajeet.

9.3 Methodology

a. To study the traditional technology and develop a suitable method for processing of crude shilajeet.

b. To evaluate the process and provide sample for evaluation by SDVK.

c. To develop standards for examination of crude/raw & processed shilajeet.

9.4 Process Development

Raw shilajeet, that is commercially available contains varying proportion of impurities stretching from rock pieces to very fine clay like substances, and needs extensive purifications prior to its use.

The main operations in its refining involve.

a. Crushing
b. Extraction with water
c. Filtration
d. Concentration.

Crushing

The physical condition of the raw material available varied from soft to hard lumps. In case of hard briltle iot jaw crusher may be used. Since small lots of sample were made available, crushing has been done mannually.

Extraction

To understand the physical characteristics of its dissolution, filtration and concentration a few batches of processing by room temp acqueous extraction have been carried out. Of the following problems faced during experimental studies both on bench scale and pilot plant, filtration and concentration due to frothing, the latter has been successfully solved. Trial experiments to improve the filtration process is being continued. The results of processing of some batches of Shilajeet are given in the following table.

Table

Raw material	Soft Extract
20 kg	9.7 kg
97 kg	36.0 kg
100 kg	34. 0 kg
50 kg	21.5 kg
35 kg	14.0 kg

In onder to improve the processing method a few more batches were processed using water preheated to 50°C and stirring mechanically. A marked improvement in the overall performance has been noticed. This process will be evaluated for its suitability to adopt in an industrial scale.

Acceptability of Soft extract by SDVK

Soft extracts of Shilajeet obtained during the above studies were provided to SDVK for product evaluation. The SDVK confirmed in the co-ordination committee Meetings that the sample is acceptable to them and also to the patients who regularly take shilajeet.

Analytical work on Shilajeet

Raw Shilajeet is prone to be adulterated. In order to ensure the authenticity of shilajeet standards for qualitative examination of crude / raw Shilajeet have been developed. As the active constituent of Shilajeet is not known, it was decided to fix its quality control standards with some constituents which are commonly present in all the samples of Shilajeet tested so far. It was found that amino acids and

benjoic acid are the common constituents present. Therefore standard of TLC finger print of amino acids and isolation and identification of benjoic acid have been developed as a quality control standard to check the quality of the raw as also processed shilajeet.

Future work Plan

1. Further improved processing method will be developed.
2. Processing of raw Shilajeet will be carried out using the already developed technique and the product supplied to SDVK till their new proposed plant is commissioned.
3. A final technical report will be prepared and submitted to the concerned agency.

Project No. 10: To develop technology for production of total Ergot alkaloids

10.1 Background & Objectives

Ergot is a fungus parasitic on cereal crops especially on rye. It has got medicinal value. Ergot has got alkaloids derived from lysergic acid. The ergot alkaloids in clinical use are ergotamine and ergometrine; ergometrine has got oxytocic properties and ergotamine is used for migranes.

The cultivation of ergot was successfully accomplished in the herbal farms of Department of Medicinal Plants on an experimental scale. It was thus considered desirable to develop a process for the extraction of total alkaloids of ergot. Some exploratory work was carried on the extraction of total alkaloids using different solvent systems. However, the cultivation of ergot was not maintained and therefore ergot sclerotia were not available. It was therefore decided to keep the project in abeyance till the cultivation of ergot is taken up on a regular basis.

10.2 Present status

The project has been dropped due to non-availability of ergot sclerotia and stoppage of its cultivation.

10.3 Team memoers

Dr. (MRS) Timila Shrestha

Mrs. Padma Prajapati

Mr. P.P. Bista

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Project No. 11:

Project Title: Techno-economic study for production of Caffeine from tea-waste.

11.1 Introduction

Caffeine occurs in plants such as tea, coffee, mate leaves and guarana nuts. In the tea growing countries, tea leaves have been commonly used for manufacture of caffeine. In the process of manufacture of tea, 2 - 5 % total green leaves are separated as fibrous part of tea; some flops are also separated. These fibrous parts, flops and dust along with those damaged due to storage and other reasons are called tea waste. According to HMG, Dept. of Excise, tea - waste is either burnt or dumped in soil in presence of excise representatives. Like its source from which it comes the tea-waste contains caffeine, which has world wide demand. In countries where tea leaves are in abundant supply, caffeine is manufactured as a by-product of tea industry. Nepal imports caffeine while it has large quantities of tea - waste which is dumped every year. In the year 1985 alone tea waste worth US $. 8,095.9 was dumped.

Table 1

Available tea - waste (Kg) in Nepal.

Fiscal year	Govt. under taking	Private sector	Total
81	2921.92	7943.12	10865.04
82	3610.90	9246.96	12851.86
83	4774.05	9659.74	14433.79
84	6218.34	11059.40	17277.74
85	8277.08	10815.10	19082.96

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With the increased production of tea, the quantity of tea-waste available will also increase.

11.2 Objectives

To develop a process for manufacture of caffeine from tea-waste and study its techno - economic feasibility in Nepal.

11.3 Output

11.3.1 Survey of samples

Samples of tea - waste were collected from different parts of Nepal and analysed for their caffeine content the results obtained are given in table 2.

Table 2 % of caffeine in samples studied

Name of the sample source	% caffeine
Tokla	6
Kanyam (stalk)	4.05
Ilam (orthodox)	3.04
Soktim	4
Giribandhu	4.5
Nakalbanda	4.65
Himalayan	4.05
Satighatta	2.00
Mittal	4.2
Budhkaran	2.95
average	3.94

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11.3.2 Bench scale studies for the production of caffeine.

Three methods for the production of caffeine were studied at Lab. scale out of which the method given below gave the best yield.

100 g of tokla CTC was mixed with 100 g of lime, boiled with 500 ml of water for 20 minutes. The rxn mixture was filtered and the filtrate was treated with Magnesia and filtered once again. The filtrate was concentrated to crystallization concentration left to cool whereby crude caffeine is obtained by filtration yield 4 %.

Conclusion

The method described above seems satisfactory for production of caffeine. It is intended to up scale and work out the Techno-economics of production.

Recommendation

1. The study should be continued at pilot scale and obtain technoeconomic data.
2. Work out proper mechanism for procuring tea-waste, which is so far controlled by excise regulation and is either dumped or burnt.

Team members:

Dr. P.M. Adhikari - Co-ordinator

Mr. Bhaweshwar Das

Project No. 12: Production of l-Dopa from mucuna Seeds.

12.1 Background

Mucuna pruriens a herbaceous plant belonging to the family Leguminosae grows wild in Terai region of Nepal. The beans of this plant are rich in l-Dopa, which is used as a medicine against parkinsons disease.

12.2 Objective

The objective of this project is to develop a process for the large scale production of l-Dopa from mucuna seeds.

12.3 Output

The mucuna seeds were collected from the field. Some difficulty was experienced in the collection of seeds as the pods have a highly allergic furry coat. Although some earlier work was carried out using the indigenously available seeds, it become evident that collection & work up of these seeds will pose logistic difficulties. It was therefore decided decided to cultivate alternate varieties. It was found out that the Brazilian variety has the pods without the allergic furry coat. So the cultivation of this variety was tried in the Hetaunda Herbal farm. The cultivation is doing well in the experimental basis and about 50 Kgs. of seeds have been collected so far.

The analysis of the six different varieties of mucuna growing wildly in the Terairegion of Nepal, showed l-Dopa content from 4 - 9 % . The highest percentage of l-Dopa was obtained from Mucuna pruriens. The analysis of seeds of this species showed l-Dopa content 9.2 %, moisture content 12.2 % and oil content 1.6 %.

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Twenty batches of 500 gm size of seed powder were processed for the extraction of l-Dopa. An average of 4.2 % yield of the B.P. grade product was obtained. All of l-Dopa could not be extracted from the seed powder. Analysis of the marc and mother liquor showed the presence of l-Dopa as 2.7% and 1.07% respectively. Efforts are being made to extract the remaining l-Dopa from the marc as well as from mother liquor.

The Brazilian variety planted in Hetauda farm showed the presence of about 9% of l-Dopa. On processing the yield of l-Dopa obtained was 3.8%.

Some 300 gms of l-Dopa (97% pure) are in hand at present.

Some modifications in the process are being tried in order to obtain higher yield of l-Dopa. A trial for the extraction is underway in pilot plant.

12.4 Conclusion

Seed powder of Mucuna pruriens from wild showed the presence of 9.2 % of l-Dopa. 4.2 % of l-Dopa could be isolated on processing. This seems quite promising. Brazilian variety cultivated in Hetauda farm showed 9% of l-Dopa content and the yield obtained after processing was 3.8% which is commercially promising too. Thus Brazilian variety could be used instead of wild Mucuna pruriens. By using this variety we can overcome the problem of allergy due to the furry coat of pods of wild mucuna.

12.5 Future Plan

a. To up scale the process on pilot plant determine the techno-economic parameters.
b. To submit samples of l-Dopa of B.P. grade to RDL and HPPCL for market acceptance.
c. To up scale the cultivation of the Brazilian variety & to introduce it to the farmers.

Project No. 13. Production of essential oil from Juniper berries

13.1 Background

Juniper berries oil is produced commercially by steam distillation of ripe fruits of Juniperus communis. In Nepal, three species of Juniper grow wild. These include Juniperus communis. J. microphylla, and J. recurva. In view of its economic importance investigation on the essential oil content of the berries of Nepal Juniperus was initiated.

13.2 Objective

a. To investigate Juniperus species of Nepal as a commercial source of Juniper berry oil.

b. To develop a method for processing of Juniper berry to extract export grade oil.

13.3 Methodology

a. To collect Juniper berries from various parts of the country and distill these to obtain the essential oil.

b. To evaluate the quality of the oil.

c. To distill at pilot plant scale and evaluate the techno-economics of the oil production .

13.4 Chemical investigation

Two types of berries (big and small sizes) of Juniperus recurva were collected from Rasuwa district. Both these samples were crushed and hydro-distilled to obtain volatile oils. The yield were as follows.

Big berries - 1.26 % and small berries 2.03 % Chromatographic examination of the oil indicated the presence of terpenic hydrocarbons with the following composition.

Hydrocabons (tentatively identified)	Big size berries	Small size berries
α - pinene	5.7 %	4,2 %
β - pinene	26.7 %	1.5 %
Myrcene	4.03 %	27.58 %
Limonene	56.55 %	57.37 %

The GLC comparision of the above two oils with that of commercia sample of Juniper berry oil showed that the monoterpenic composition of the Nepal Juniper berry oils are qualitatively very similar to that of commercial sample. However, the odour and relative concentration of each of these four constituents vary sinificantly.

13.4 Distillation

HPPCL has installed a distillation unit at Ramechap district. As a trial production it has distilled Juniper berries oil and submitted the oil to RDRL for chromatographic analysis. The oil was examined and the report was sent to HPPCL.

13.5 Future Work Plan

Investigation on Juniper berries oil obtained from various species will be continued. On the basis of work carried out at RDRL a commercial scale distillation of Juniper berries oil at a suitable location will be recommended.

Project No. 14: Production of hyoscyamine and hyoscine from Dhatura species.

Due to non-availability of adequate plant material this project was dropped since 1987.

Project No. 15: Exploitation of Essential Oil Bearing Plants in Nepal.

15.1 Background

Plants provide a large number of industrially important products amongst which essential oils occupy a place of considerable importance. There are of economic value and are used in perfumes, flavour and medicines. Previous studies have shown that a large number of essential oil bearing plants occur in Nepal and these as raw materials are abundant for the production of essential oils. But this resource remained to be tapped for the benifit of the country. In view of their economic importance a screening programme for testing the content of essential oil in the Nepalese flora and their evaluation as raw material for future production of aroma compounds was commenced. As a result of this study a few essential oil bearing plants occuring in wild have been selected for essential oil production and these products have successfully been marketed within the country as well as in foreign countries. Such systematic research and development works on essential oil can have significant impact upon the establishment and growth of essential oil industry in Nepal. This fact is reflected in Table 1 which shows the trend of essential oil sale in the last six years. The R & D work which led to attain the situation are briefly discussed below.

TABLE 1

Sale of Essential Oil to

Year	Domestic		India		Overseas		Total	
	Qty. (Kg)	Value (Rs. x1000)	Qty. (Kg.)	Value (Rs.x1000)	Qty. (kg.)	Value (Rs. x1000)	Qty. (Kg.)	Value (Rs x 1000)
1981/82	805	10.45	-	-	-	-	805	10.45
1982/83	1398	21.02	31	7.72	3	3.53	1432	32.27
1983/84	3230	47.98	417	62.65	101	45.13	3748	55.76
1984/85	6167	33.66	1620	169.66	487	308.82	8274	615.14
1985/86	8108	287.68	5827	266.80	1513	1072.50	25448	1626.98
1986/87	14985	290.52	1217	564.65	2205	1566.31	18407	2421.48

Source: Herb Production & Processing Co. Ltd.
Sales Section.

15.2 Objectives of the Project

Following three broad R & D objectives were considered for the development of essential oils as an exportable commodity of the country.

1. Screening of Nepalese wild flora with an objective of discovering either new source of essential oil which already have established use or new essential oils of economic value in perfumery industry.

2. Introduction of commercially important exotic plants with established aromatic value.

3. Development and improvement of processing technology and quality control of essential oil of established economic value.

15.3 Methodology

1. Collection of plant specimens from different parts of the country during suitable season and their proper botanical identification.

2. Introduction of commercially important exotic plants with established value at herbal farms located at different agroclimatic region of the country.

3. Distillation of the collected and introduced plant specimens to determine their oil content.

4. Evaluation of quality of the oil for their market potential.

15.4 Screening of Wild Flora

In keeping with the above objectives and following the above methodology, collection of plants from different parts of the country were made and their essential oil content were determined. The list of such plants with their oil content is given in Table 2.

Table 2

List of Essential Oil Bearing Plants identified during this project period

Name of Plants	Oil % (v/w)
Abies spectabilis	0.31
Acorus calamus	0.9
Agastache furgose	2.71
Amomum subulatum	1.5
Aristolochia sps.	0.03
Artemisia indica	0.77
,, parviflora	0.20
,, vulgaris	0.93
Bauhinia purpurea	0.08
Bupleurum candollei	0.16
Callistemon lanceolatus	0.34
Cannabis sativa	0.19

Name of Plants	Oil % (v/w)	
Cedrus deodara	6.04	
Celastrus stysus	0.59	
Chenopodium album	trace	
Cinnamomum camphora	0.10	
,, tamala	0.1	bark
	1.05	leaf
Clausena willdenowii	0.17	
Costus sps.	0.05	
Cotoneaster microphylia	trace	
Cumimum cyminum	0.37	
Curcuma domestica	4.17	
Cymbopogan flexuosus	0.72	
,, martini	0.47	
,, winterianus	0.11	
Cyperus rotundus	0.09	
Elettaria cardamomum	1.6	
Eucalyptus camaldulensis	4.24	
,, citriodora	4.42	
Eupatorium adenophorum	0.4	
,, glandulosum	1.31	

Name of Plants	Oil % (v/w)
Foeniculum vulgare	1.54
Gaultheria fragrantissima	0.9
Grewia glabra	0.12
Hebiscus abelmoschus	0.18
Hedychium sps.	0.11
Heracleum nepalense	0.33
Houttuynia cordata	0.12
Inula cappa	0.23
Juglans regia	0.02
Juniperus recurva	1.37
Juniperus indica	0.43
Laggera alata - shuttj	0.5
Larix himalaica	0.75
Lantana camera	0.14
Legoseptrum canum	0.15
Linguleria siberica	3.7
Magnolia grandiflora	0.17
Melia azedorach	trace
Mentha arvensis	0.5
,, piperita	0.4

Name of Plants	Oil % (v/w)
Michelia sps.	0.35
Micromeria biflora	0.7
Murraya koenigii	0.43
Nardostachys jatamansi	3.38
Nepeta ruderalis	0.39
Ocimum americanum	0.6
,, bacilicum	0.89
,, kilimandischaricum	5.7
Osmanthus fragrans	0.5
Pelargonium sps.	0.3
Piper longum	0.2
Pinus roxburghii	0.11
,, wallichiana	0.55
Pyrus pashia	0.06
Rabdosia coetsa	trace
Raphanus sativus	0.07
Rosmarinus sps.	2.33
Salix sps.	0.09
Senecao densiflorus	0.33
Skimmia laureola	0.8 - 1.6

Name of Plants	Oil % (v/w)	
Sugandha kokila	5.2	fruits
	2.9	leaf
	0.27	bark
	0.1-0.3	wood
	0.22	root
Tagetes glandiflora	1.22	
Tanacetum nuliglungla	0.8	
Thymus serphyllum	1.16	
,, vulgaris	1.07	
Tsuga dumosa	0.48	
Valeriana wallichii	0.8	
Vetiveria zizanioides	3.24	
Viola sps.	0.23	
Vitex negundo	0.2	
Zanthoxylum alatum	2 - 8	
Zingiber officinale	0.6	

As a result of screening work, a number of plants have been identified as of value for economic production. These plants for which methods are developed for commercial production of their essential oils are given in Table 3. Plants which are under investigation for their exploitation are given in Table 4.

Table 3

Plants for which methods are developed for commercial production of essential oil.

S.No.	Plants Name	Parts	Present Status
1.	Sugandhakokila	Fruits	Commercially produced and for export
2.	Zanthoxylum alatum	Fruits	Commercially produced and for export.
3.	Acorus calamus (Calamus oil)	Rhizomes	Commercially produced and for export.
4.	Pinus roxburghii (Turpentine oil)	Resin	Commercially produced and for export and for local consumption.
5.	Gaultheria fragrantissima (Wintergreen oil)	Leaves	Commercially produced and for export.
6.	Skimmia laureola	Leaves	Process technology developed.
7.	Eucalyptus camandulensis	Leaves	Process technology developed for medicinal eucalyptus oil rich in ceniole.

Table 4

Plants under investigation

S.No.	Plant Name	Parts	Present Status
1.	Pine needle oil	Leaves	Experimental stage.
2.	Juniper berries oil	Berries	Experimental stage.
3.	Cinnamomum camphora	Leaves	Experimental stage. Uneconomic.
4.	Litsea citrata	Fruit	Experimental stage. Uneconomic.

15.5 Introduction of Commercially Important Exotic Plants

The wide salubrious climatic variation available within the country provide a very favourable setting to introduce commercially important aromatic plants for cultivation from other parts of the world. It is estimated that over 200 essential oils derived from plant sources are of economic importance in the world market. The size of the world market is of the order of U.S. $ 1.5 billion. Even if a small part of these essential oils are produced within the country it will bring in extra income. Keeping this in mind, the Department has introduced a number of exotic essential oil bearing plants within the country and development work relating to growth response, oil content, quality of oil and processing technology of the introduced plants were studied. Of the many exotic plants the following have been successfully established and at present, some of these are under commercial cultivation.

Name of the oil	Status
Mentha arvensis	Commercial
Mentha piperitta	Experimental/commercial
Lemongrass	Commercial
Palmarosa	Commercial
Citronella	Commercial

Prior to commercialisation of the above mentioned oils the following systematic studies were undertaken.

1. Introduction and establishment of exotic plants at herbal farms located at different agro-climatic zones.
2. Standardisation of harvesting and distillation process. (Load, temperature and duration)
3. Analytical control for each batch distillation. (For this purpose a batch control form for the production of essential oil is filled at the site of distillation and a sample of the oil from each batch was subjected to the gas liquid chromatography (g.l.c.) examination. Physico-chemical analysis of representative samples of the oils were carried out following the methods described in British Standard Methods of Test for Essential Oil (B.S. 2073; 1976).

A number of other commercially important aromatic plants have also been introduced (Table 5) and the results of suitability for their extensive cultivation are awaited.

Table 5

List of commercially important aromatic plants introduced in various herbal farms for cultivation studies.

1. Abelmoschus moschatus
2. Acorus calamus
3. Artemisia bubia
4. A. orbritum
5. A. pallens
6. Carum carvi
7. Coriandrum sativum
8. Eletteria cardamomum
9. Eucalyptus citriodera
10. Foeniculum vulgare
11. Geranium nepalensis
12. Jasminum sambac
13. Lavandula spica
14. L. vera
15. Mentha citrata
16. M. spicata
17. Nyctanthus arbor - tristis
18. Ocimum basilicum
19. Ocimum kilimandischaricum
20. O. fenniflorum

In order to meet the demand with a sustained supply of Sugandha kokila fruits it has become essential to commence a programme of plantation with this valuable tree. Accordingly, studies were conducted at Godavari for its germination from seeds. A two-year study resulted in finding suitable time for germination and this study resulted in preparing 30,000 seedlings for their plantation at different parts of the country. A major portion of these seedlings is in the process of transfer to the area where it has well adopted. Plantation work will be undertaken in a higher scale in collaboration with the Forests Department.

Problem: Its botanical identity remains to be established.

Note: For the work on fixed oil from spent berries of sugandhakokila see separate report. (Project No.5)

15.6.2 Timur Oil

Zanthoxylum alatum (syn. Z. armatum) local name: Timur grows wild throughout the mid-hill region of Nepal. Its fruits are used as spices. The fruits, on hydro-distillation yield an essential oil (2.3 - 8.1 percent v/w) with characteristic odour. Analysis of the oil by a combination of chromatographic and spectroscopic techniques showed 65 components out of which 13 major components were identified. Of the components identified for the first time were α-pinene, α-thujene, β-pinene, sabinene, p-cymene, terpinen-4-ol, piperitone, carvon and cuminaldehyde. The presence of myrcene, limonene, linalool and methyl cinnamate in the oil was reconfirmed. The major constituents in the oil are limonene (27.0 %) and linalol (53.9 %).

Further works on the availability, trade practices and quality assessment of timur fruits were carried out.

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As a result of R & D efforts, the timur oil also has been introduced to the essential oil market as a product of Nepal. The oil has found acceptance by perfumery industry.

Problem: The price of the raw material fluctuates to the extent that it become uneconomical in certain years to process timur fruits for its oil. For example:
Price in 1982 - Rs. 5 - 8 / Kg.
,, ,, 1988 - Rs.40 - 50 / Kg.

15.6.3 Oil of Wintergreen

Gaultheria fragrantissima is found growing wild in the mid-hill region of central and eastern part of Nepal. Its leaves and twigs, on hydro-distillation yield oil of wintergreen (0.9 % v/w). The physico-chemical constants of the oil is comparable to that of wintergreen oil from G. procubens produced in America.

Gas liquid chromatographic analysis of the oil revealed 11 components of which methyl salicylate (97 %) and longifolene (0.8 %) were identified. Other minor significant components of the oils were fentatively identified as α-pinene, β-pinene, Δ^3-carene, humulene and caryophyllene oxide by using GC - MS.

Methyl salicylate which accounts for the major component has a wide application in pharmaceutical and flavour-perfumery industries.

In view of exploiting this potential raw material as a source of methyl salicylate, some parameters such as seasonal variations and method of distillation to maximise the yield of the oil were studied.

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15.6.4 Acorus calamus

Acorus calamus (Nepali name: Bhojo) is found growing wild mostly in the Western and Central region of Nepal (Altitude 1300 - 2550 meters). Export figures of calamus rhizomes to India for the following two years are:

Year	Quantity	Value (Rs.)
1983/84	11,557 kg	56,000/-
1984/85	14,329 kg	1,61,000/-

(Source: Foreign Trade Statistics Published by Dept of Customs, Ministry of Finance, H.M.G.).

Hydro-distillation of coarsely powdered calamus rhizomes yielded a yellow - brownish oil (yield 4 %). Gas liquid chromatographic analysis of the oil showed β-asarone as major constituent, the content of which varied between 78 to 91 percent.

Herbs production and processing Co. Ltd. sponsored a project of developing distillation method for commercial production of calamus oil. Accordingly several batches of distillation of calamus oil both in bench scale and pilot scale were carried out. Several parameters such as duration of distillation, steam/water distillation, prior treatment of the powder material etc. were taken into consideration. A technical report for the production of calamus oil is prepared and handed over to HPPCL on April 1987. On request from HPPCL one of the scientist from RDRL was deputed to study the problems encountered by HPPCL during distillation of calamus (16 - 18 Nov., 1988). Appropriate recommendations were made for adoption by HPPCL of process technology developed at RDRL.

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On arrival of UNIDO Expert Mr. Narsimha, this project was once again undertaken on Feb. 1988 at RDRL with an objective of further improvement on process development for the distillation of calamus oil. Based on this study a technical report is prepared.

15.6.5 Eucalyptus camaldulensis

Eucalyptus camandulensis is grown under reforestation program at Sagarnath with an objective of meeting fuelwood demand of the country. The leaves of this plant is a waste. In order to find out the possibility of converting this waste into a useful product a study was commenced. The study involved distillation of leaves to obtain eucalyptus oil, seasonal variation of oil and also its major constituent, possibility of selecting better clone for high yielding variety in terms of fuelwood and essential oil etc. A brief account of this study is given below.

Leaves of E. camandulensis on hydro-distillation yielded an oil (up to 2.5 % v/w, average 1 %) which on chromatographic analysis showed the presence of α-pinene, β-pinene, limonene, cineole, borneole, terpenole and other unidentified minor components.

Seasonal Variation Study on E. camaldulensis

Leaves from a large number of individual trees were collected every fortnight and the total volatile oil and cineole content were determined for one year. It was found that the oil content variation amongst individual trees was 0.25 to 2.5 %, the majority of the tree however had more than 1.0 %. Similarly the cineole content also varied between 6.6 to 88 %. The majority of the plant yielded

.../...

oils which have more than 55% cineole content. The seasonal variation in the oil content was not significant. In view of such a diversity that exists amongst the plants clonal plantation of superior candidates has become essential to maximise the project benifit. Accordingly tissue culture method of large scale clonal production was tried and the initial results have shown that this method has a possible commercial application.

Utilisation of the oil from E. camaldulensis

British Pharmacopoca describes eucolyptus oil and states that the oil should contain not less than 70% w/w cineole. In order to meet this requirement, the oil distilled from E. camandulensis was rectified to obtain an oil with over 70% cineole content (yield 75%). The rectified oil is used in various medicinal preparation with satisfactory results. Royal Drugs Ltd. has approved the oil for use in their various formulated products.

15.7 Summary

1. Sugandha kokila oil has been developed as a new essential oil and marketed. Fixed oil from Sugandha kokila berries has a great economic potential.
2. Timur oil from Zanthoxylum alatum fruits has been developed and its marketing has started.
3. Techno-economics on the production of wintergreen oil oil from Gaultheria fragrantissima leaves have been worked out and it is identified as a potential product for export.
4. Techno-economics on the production of Calamus oil from Acarus calamus rhizomes have been worked out and the oil is produced commercially for export.

.../...

5. Eucalyptus camandulensis has been identified as a new source of eucalyptus oil (cineole type) and process for the production of Pharmacopoeal grade oil is being worked out.

Project No, 16: Development of Quality Standards for plants used in Ayurvedic Drugs

16.1 Background

Ayurvedic system of medicine is widely accepted & procured in Nepal, and Ayurvedic drugs continue to be in considerable demand. The Government is running an Ayurvedic drug manufacturing unit i.e. Singh Durbar Vaidyakhana (SDVK) on a no loss no gain basis. SDVK has chosen twenty-five formulations as its priority preparations and these are regularly manufactured in this factory. For the preparation of these drugs 107 different medicinal plants are used. The collection of these plants is carried out by local people, who do not have knowledge of identification, and many collect a wrong plant because it has a similar name. There is also the chance of adulteration.

16.2 Objective

To develop pharmacogonotic standards for plants used in important Ayurvedic drugs.

16.3 Work done

Considering these facts, Royal Drug Research Laboratory has initiated a project to prepare standards for these plants for proper identification, quality control and analysis. Such standards for twenty plants were prepared and compiled in 1986 in a book entitled " Standards of Ayurvedic Crude Drugs: Volume - 1". Volume 2 of this series has been completed which also contains standards on another twenty plants. Works on further twenty plants is completed and it is at typing stage.

The attached tables provide lists of the 107 plants for which the standards are being prepared.

16.4 Conclusion

Volumen 1 of the series was sent to various related organisations for their comments which were favourable.

Table 1

List of the plants described in volume 1 (published)

1. Acorus calamus (rhisome).
2. Aconitum spicatum (root).
3. Amomum subulatum (fruit).
4. Cinnamomum tamala (leaf).
5. Cinnamomum zeylanicum (bark).
6. Cuminum cyminum (fruit).
7. Datura metel (leaf).
8. Datura metel (seeds).
9. Elettaria cardamomum (fruit).
10. Embelia ribes (fruits).
11. Foeniculum vulgare (fruit).
12. Glycyrrhiza glabra (root and stolon).
13. Picrorhiza scrophulariaeflora (root and rhizome).
14. Piper longum (fruit).
15. Piper nigrum (fruit).
16. Swertia chirata (plant).
17. Perminalia belerica (fruit).
18. Terminalia chebula (fruit).
19. Valeriana jatamansi (rhizome and root).
20. Zingiber officinale (rhizome).

Table 2

List of the plants described in volume 2 (work completed, about to publish)

1. Aegle marmelos (fruit).
2. Butea monosperma (seed).
3. Carum carvi (fruit).
4. Cedrus deodara (bark).
5. Coriandrum sativum (fruit).
6. Curcuma longa (rhizome).
7. Curcuma zedoaria (rhizome).

8. Eclipta prostrata (plant).
9. Holarrhena antidysenterica (seed).
10. Mahonia napaulensis (bark).
11. Myristica fragrans (seed).
12. Nardostachys grandiflora (root and rhizome).
13. Phyllanthus emblica (fruit).
14. Piper longum (whole plant).
15. Plectranthus mollis (whole plant).
16. Rauwolfia serpentina (root).
17. Saussurea lappa (root).
18. Solanum nigrum (fruit).
19. Tabernaemontana divaricata (whole plant).

Table 3

List of the plants described in volume 3
(On process of completion).

1. Adhatoda vagica (leaf).
2. Apium graveolens (fruit).
3. Asparagus racemosus (root).
4. Azadirachta indica (leaf).
5. Cannabis sativa (branches).
6. Cissampelos parcira (tuber).
7. Coptis teeta (rhizome).
8. Cyperus rotundus (tubera).
9. Hollarrhena antidysenterica (bark).
10. Nigella sativa (seed).
11. Operculina turpethum (root).
12. Oroxylum indicum (bark).
13. Punica granatum (pericarp of fruit).
14. Rubia cordifolia (root).
15. Solanum xanthocarpum (fruit).

16. Symplocos paniculata (bark).
17. Sysygium aromaticum (flower bud).
18. Tinospora cordifolia (stem).
19. Trachyspermum ammi (fruit).
20. Woodfordia fructicosa (flower).

Table 4

List of the plants for which the standards have to be worked out

1. Abies spectabilis.
2. Acacia catechu.
3. Aconitum heterophyllum.
4. Aegle marmelos (leaf and seed).
5. Allium sativum.
6. Aloe succortrina.
7. Areca catechu.
8. Bacopa mionniera.
9. Baliospermum montanum.
10. Bambusa arundinacia.
11. Berberis aristata.
12. Cinnamomum camphora.
13. Croton tiglium.
14. Cubeba officinale.
15. Commiphora mukul.
16. Curculigo orchioides.
17. Cyperus scariosus.
18. Desmodium gangeticum.
19. Desmotrichum fimbriatum.
20. Ephedra gerardiana.
21. Gmelina arborea.

22. Suizotia abyssynica.
23. Ichnocarpus frutescens.
24. Jasminum auriculatum.
25. Leucas cephalotes.
26. Nimosa pudica.
27. Magnifera indica.
28. Myristica malabarica.
29. Nymphaea stellata.
30. Ochrocarpus longifolius.
31. Ocimum amoricanum.
32. Ocimum sanctum.
33. Papaver somniferum.
34. Piper chaba.
35. Plumoago zeylanica.
36. Premna integrifolia.
37. Prunus cerasoides.
38. Pueraria tuberosa.
39. Pongamia pinnata.
40. Scindapsus officinalis.
41. Stephenia hernandifolia.
42. Strychnus nux-vomica.
43. Tribulus terrestris.
44. Trichosanthes dioica.
45. Vetiveria zizanioides.
46. Valeriana hardwickii.
47. Vanda roxburghii.

Project No.17: Development of formulations based on Ayurvedic drugs.

17.1 Background:

Ayurvedic system is widely accepted and practised in Nepal, and at a rough estimate about 80% of the people of Nepal would be depending upon Ayurvedic drugs. Many important medicinal herbs are available in big quantities in Nepal due to favourable geographical conditions. In most of the Ayurvedic preparations, standardisation of crude herbs and finished products are not done scientifically so their action can vary from batch to batch. The preparation of standardised formulation based on Ayurvedic prescriptions, following good manufacturing practises, particularly for some common ailments, therefore seemed of importance for making better use of Ayurvedic drugs. Other aspects are to ensure safety of these drugs by toxicity studies, develop new dosage forms for ease of administration & better acceptance for taste & odour. This project describes the work done in this area.

17.2 Objectives

a. Develop new formulations based on Ayurvedic drugs for use in modern therapeutics.

b. Develop suitable standards for raw materials & finished products.

17.3 Output

The following formulations have been developed, The details of their ingredients & cost are given in Annex.

1. Deep Heat Cream for pains
2. Pine Oil Disinfectant
3. Turpentine Liniment

.../...

4. Anticold and Antirheumatic Oil
5. Anticold and Antirheumatic Balm
6. Rauwolfia Alkaloid Tab.
7. Cough Lozenges
8. Centella Asiatice Cream for wound healing
9. Laxative-Rhubarb Tablets
10. Antidiarrhoeal Tablet
11. Antacid and Antiulcerous Tablet
12. Capsicum Ointment

Of these formulation Royal Drugs Ltd. has accepted & undertaken to market the Deap Heat Cream, Rhubarb Laxative and Anticold Antirheumatic oil for the present.

Future Work

1. Private industry is also being contacted for marketing of these formulations.
2. More such standardised formulations for other important diseases will be developed in consultation with user industries & Ayurvedic physicians.

Project No. 18 Chemopharmacological investigation of medicinal plants

Background

Nepal is endowed with a rich resource of plant species. Some of them are used by Ayurvedic physician or by local people as traditional remedies, but many of them do not find any reference or mention of their biological activity. Both with a view to explore this rich resource for development of new drugs, as also to scientifically verify the claims of the plant used in traditional remedies, it was considered of interest to systematically collect plants from different regions of Nepal and screen them for their biological activity. Those which show activity could then be subjected to detailed chemical investigation with biological activity monitoring for development as new drugs. This is of particular logistic benefit as teams of botanists and plant collectors visit different parts of Nepal under the project for economic mapping and some team would be able to collect plants for biological screening also.

18.2 Objectives

To screen plants of Nepal for pharmacological activity using the following tests.

1. Gross behavioural activity and acute toxicity test.
2. Antifertility activity
3. Anthelmintic activity (Antitapewoorm)
4. Cardiovascular activity

18.3 Methods

Extract: 50% alcohol extract after vacuum dryding at low temp, was used for test.

a. Gross behavioural and acute toxicity test was conducted according to the table as given in Appendix.

b .Effects on isolated tissues ileum and anococuggeus muscles of rat were used for the test and other parameters us were as found in standard method.

c. Antifertility activity is tested on rat and observed for antimplantation and foetal loss.

d. Anthelmintic activity was tested in mice infected with hymenolepis nana and conclusion was deduced on the basis of complete removal of infected parasites

18.4 Output

a. Gross behavioural activity, acute toxicity and effects on islated tissues.

During this period 27 plants have been investigated for toxicity and gross behaviour and in isolated tissues (Appendix). Weak spasmolytic activity were found in Anagalis arvensis, Cipadessa bacifera, colebrookia oppositifolia, Elephantopus scaber, Portulaca oleraceae, Plumbago zeylanicum, Ficus bengalensis, Salvia plebia, Sphaeranthus senegalensis, Boenninghausenia albiflora, Euphorbia hirta, Tadehagi triguetrum, Morina longifolia and Innula cappa. Among these plants that showed contractions in anococygeus muscle, in which contraction is caused by adrenergic like drugs, are Portulaca oleracea, Plumbago zeylanicum and Ficus bengalensis. Plants Showing blocking effect in anococcygeus muscle also are Plumeria rubra, Colebrookia oppositifolia, Salvia plebia, Sphaeranthus senegalensis, Boenninghausenia albiflora and Euphorbia hirta. The activity in some of these tests was strong enough to warrant detalied testing.

b. Antifertility activity

10 plants screened for their antifestility are giren in Appendix Out of these Plumeria rubra and Acacia concinna showed 60 % and 40 % inhibition of implantation at the dose of 400 mg/ kg and 25 mg/kg respectively. An interesting finding is that Acacia concinna which is generally used in hair oil showed foetal loss of 53% at the dose of 25 mg/kg.

c. Anthelmintic activity

This test was performed for 11 plants using in vitro technique. However in vivo method was also tried for 25 Plants (Appondix ...) The sesult did not show 100 % effect except with Mallotus phillipensis, which is mentioned in traditional medicine for the same purpose, but. in view of its texiuty is not widely used.

d. Cardiovascular activity

10 plants were tested for their cardiovascular effect in rat (Appendix) Most of plants showed no effect or transient fall in BP. But Potentialla peduncularis showed a fall in BP for short period.

13 Plants of aconite species were tested for acute toxicity (Appendix...). To a certain extent the result obtained has been valuable to differentiate poisonous plants from non-poisonous one.

Hypoglycemic test conducted on plants are listed in Appendix

Plants tested for microbiological activity and their phytochemical screening are listed in Appendix.

18.5 Conclusion

The manpower and other resources available for this work are limited, and to make most effective use of these resources it has been suggested to restrict the work in this project to the following specific tasks.

a. Acute toxicity and gross behavioural study of plant extracts.

b. Toxicity study of new drugs and formulation developed

c. Screening of extracts on isolated tissues and for cardiovascular activity.

d. Antifertility activity in female rats.

Project No. 19 Analysis of Drugs referred by Department of Drug Administration (DDA), Private & Public Pharmaceutical Companies and other organisatio

19.1 Background

RDRL has been designated as the staturary analytical laboratory by the Department of Drug Administration. Further most of the industrial units in Nepal are too small to have their own Quality Control Analytical Laboratories. But quality control assurance is most necessary for market acceptance of their products.

19.2 Objective

The main objective of this project is to conduct testing and standardisation of drugs and allied materials referred by Department of Drug Administration (DDA), Private & Public pharmaceutical companies and other organisations.

Tasks

1. Laboratory testing for quality assurance of drugs marketed in Nepal. (For this purpose the DDA is supplying a number of marketed samples of both Indian and Nepal origin for laboratory analysis)

2. Provide quality control services to the local pharmaceutica companies.

3. Provide analytical services to private and public organisations for other products such as crude herbs and drugs, alcoholic beverages, chemicals and allied materials.

4. Develop suitable analytical methods and also verify the analytical methods on pharmaceuticals provided by the manufacturing companies for their validity. (normally pharmacopoeal methods are followed for the analysis of medicines)

19.3 Output

Samples received from the DDA, private and public pharmaceutical companies and other organisations were analysed and the analytica reports were provided to the respective organisations. Details of the number of samples analysed during 1982/83 to 1987/88 are given in the following table:

Table

S.No.	Year	Dept. of Drug Administration	Private & public pharmaceutical companies	Other organisations	Tot
1.	1982/83	No. of samples			
		Received: 151	19	24	19
		Analysed: 115(36)**	19	24	15
2.	1983/84	Received: 150	63	224	43
		Analysed: 102(48)**	63	224	48
3.	1984/85	Received: 75	151	151	37
		Analysed: 55(20)**	151	151	35
4.	1985/86	Received: 85	137	118	34
		Analysed: 55(30)*	137	118	31
5.	1986/87	Received: 66	244	58	36
		Analysed: 41(25)*	244	58	34
6.	1987/88	Received: 34	104	64	20
		Analysed: 24	104	64	19

* The figures in parenthesis show the number of drugs which could not be analysed due to non-availability of methods of analysis. The DDA is being requested to send the analytical methods.

** The figures of fiscal year 1987/88 is for 10 months only (i.e. from July 1987 to April 1988).

Problems

1. Non-availability of analytical procedures for combination drug formulations.

2. Difficulty in procuring reference and working standards on a regular basis (reference standards are expensive).

3. Inadequacy in Biological testing facilities.

19.4 Recommendations

1. Arrangement should be made to obtain analytical procedures from the manufacturing companies specially for the combination drug formulations.

2. Appropriate mechanism should be evolved for a regular supply of reference and working standards.

3. Biological testing facilities have to be strengthened.

4. Personnel involved in quality control work should be exposed to regional/international drug quality control meeting and short visits to the quality control laboratory of developed as well as developing countries is highly desirable.

5. In view of the ever continuing escalation in prices of chemicals and equipment, the cost of analytical services is rising. It is, therefore, necessary to increase the funds provided for running this services. In part this can be done by charging for analysis the samples referred by the DDA, as is done for samples sent by private companies. The DDA can in turn charge the companies whose samples they send for analysis.

6. To upgrade the analytical facilities of RDRL it should be allowed to retain at least 50 % of the money received by it for the analytical services provided.

Project No.20.

Economic Mapping of Medicinal and Aromatic Plants.

20.1 INTRODUCTION

The diversity of physiography due to the altitudinal and climatic variations has made it possible to lodge almost all types of climate from tropical to alpine in Nepal covering merely 141,000 km^2. Hence, a large number of medicinal species are available in the Nepalese spontaneous flora. The wealth of medicinal plants may be considered as one of the important natural resources for the economy of this Himalayan country. Many of the prominent herbal drugs being utilized presently by many organized and recognized systems such as Ayurveda, Unani, Homeopathy, Allopathy, etc. happens to grow in this country spontaneously. At the same time, we have also a very old and strong tradition of use of medicinal plants in our local traditional systems.

Apart from these, for the establishment and expansion of local productions based on medicinal plants, we need to know the quantity and quality of raw materials which are available in particular areas of the country. It also appears high time to emphasize upon the importance of Natural Product Research, which is actually a systematic investigation of natural products designed to develop the natural resources of a country (Dhoubhadel, 1982).

Economic mapping of medicinal plant resource of an area is, therefore, to estimate their productivity quantitatively as well as qualitatively for economic potentiality (Bhattarai, 1984). At the same time, it also involves the concept of controlled exploitation, with a view to safeguard the existance of the species and their smooth-flow of the optimum productivity in the study area.

Uncontrolled collection of herbs from a particular locality for a number of contineous years ultimately leads to the extinction of the species from the area, and may be from the world, if due attention is not paid before it is too late.

In India, our neighbour, Ahluwalia, as far back as 1952, argued in favour of something resembling the economic mapping of medicinal plants, on the basis of statistics which showed a progressive reduction in the supply of herbs from the Kangra district, Punjab. He suggested their exploitation by rotation to allow the plant sufficient time for natural regeneration (Ahluwalia, 1952).

In the following compilation, data from 7 previous reports has been presented in a tabular form. It includes the district and season of the field survey, route followed, number of species considered and the total harvestable quantity of herbs and essential oils along the route followed, from each report (Table 1). The quantity of herbs and essential oils obtained from each species, previously described in each report, has also been presented in separate tables (Table 2-8). Table 9 includes the overall quantity of each herb and essential oil from all the 7 previous reports combined.

Table 1

S.N.	District & duration of field survey	Route followed	No. of species considered	Harvestable quantity of herbs & ess. oils along the route followed	Reference
(1)	(2)	(3)	(4)	(5)	(6)
1.	Jumla & Mugu; May-June, 1984	Jumla-Chaudahabise khola-Dhaulidaha; Jumla-Jaljale-Hadsija-Chuchamara-Khatyar khola-Rara-Gumgadi-Pina-Bhulbhule-Danfey; Jumla-Tatopani.	40	Herbs: 587.435 tons Ess. oils: 44.27 tons (Table 2)	Bojor et al., 1984.
2.	Surkhet, Dailekh, Kalikot & Jumla; Aug.-Sept. 1984	Surkhet-Ranimatta-Dailekh-Mabu-Nagma-Tatopani-Nagma-Hadsija-Chautha; Danfey-Patmara-Jumla; Bhulbhule-Chautha-Danfey; Jumla-Dhaulidaha-Talphi-Deochaur; Jumla-Tatopani.	58	Herbs: 555.705 tons Ess. oils: 38.805 tons (Table 3)	Bhattarai et al., 1984.

Table 1 continued

(1)	(2)	(3)	(4)	(5)	(6)
3.	Syangja, Parbat, Baglung, Myagdi & Mustang: April-June, 1985	Pokhara-Naudanda-Kushma-Baglung-Beni-Darbang-Gurjakhani-Dhorpatan-Beni-Tatopani-Jomsom-Muktinath-Naudanda-Pokhara.	54	Herbs: 2094.285 tons Ess. oils: 41.005 tons (Table 4)	Bhattarai et al., 1985.
4.	Kaski, Syangja, Parbat, Baglung, Myagdi & Mustang: Sept.-Oct., 1985	Pokhara-Ghandruk-Tatopani-Jomsom-Muktinath-Tatopani-Beni-Dhorpatan-Galkot-Baglung-Naudanda.	43	Herbs: 997.805 tons Ess. oils: 20.050 tons (Table 5)	Joshi et al., 1985.

Table 1 continued

(1)	(2)	(3)	(4)	(5)	(6)
5.	Dhading, Kuwakot, Nasuwa & Sindhupalchok; Sept.-Oct., 1986	Sundarijal-Helambu-Gosaikunda-Langtang-Kyanjing-Syabrubesi-Dhunche-Trishuli; Malekhu-Dhadingbesi-Trishuli-Dhunche-Syabrubesi-Rasuagadi-Langtang-Chandanbari-Gosaikunda- Dhunche-Trishuli.	30	Herbs: 205.41 tons Ess. oils: 43.0 tons (Table 6)	Bhattarai, 1986.
6.	Rukum, Dolpa & Jumla; May-July, 1987	Chaurjhari-Simi-Dunai-Phoksundo-Gandala-Dunai-Tibrikot-Kaigaon-Maure-Jumla.	23	Herbs: 53.485 tons Ess. oils: 124.3 tons (Table 7)	Bhattarai, 1987.

Table 1 continued

(1	(2)	(3)	(4)	(5)	(6)
7.	Ramechhap and Dolakha districts; Jan.- Mar., 1988	Khurkot- Ramechhap-Dhobi- Bamti- Jiri-Charikot- Torikhet-Lamabagar-Lumnang.	12	Herbs: 71.05 tons Ess. oils: 18.45 tons (Table 8)	Bhattarai, 1988.

Table 2

List of medicinal and aromatic plants alongwith the corresponding quantities that has been proposed to be harvested from the study area (Jumla and adjoining areas I; Bojor et al., 1984)

Plant species	Quantity (ton)
1. Abies spectabilis	13.6
2. Acorus calamus	0.65
3. Artemisia indica	0.75
4. A. sieversiana	0.6
5. Berberis aristata	0.525
6. B. asiatica	0.15
7. B. wallichiana	0.1
8. Bergenia ciliata	1.2
9. Betula utilis	345.75
10. Cedrus deodara	0.55
11. Dioscorea deltoidea	9.85
12. Dryopteris sp.	4.1
13. Ephedra gerardiana	0.3
14. Fragaria nubicola	1.74
15. Filipendula vestita	0.025
16. Hedera nepalensis	0.1
17. Hippophae rhamnoides	0.12
18. Juglans regia	102.1
19. Juniperus indica	75.0
20. Mentha longifolia	1.05
21. Picea smithiana	5.92
22. Pinus wallichiana	24.2
23. Populus ciliata	13.4
24. Potentilla fulgens	4.32
25. Primula strumosa	0.05

Plant species	Quantity (ton)
26. Prinsepia utilis	4.85
27. Rheum australe	6.0
28. Rosa macrophylla	0.125
29. R. sericea	3.15
30. Rumex nepalensis	4.295
31. Salix babylonica	0.06
32. Salvia moorcroftiana	0.6
33. Sambucus hookerii	0.35
34. Swertia chirayita	2.1
35. Thymus serphyllum	2.0
36. Tussilago farfara	1.25
37. Urtica dioica	0.1
38. Verbascum thapsus	0.035
39. Viburnum cotinifolium	0.44
40. V. erubescens	0.2

Table 3

List of medicinal and aromatic plants along with the corresponding quantities that has been proposed to be harvested from the study area (Jumla and adjoining areas II; Bhattarai et al., 1984)

Plant species	Quantity (ton)
1. Abies spectabilis	10.18
2. Adhatoda vasica	0.365
3. Agave americana	0.35
4. Ageratum conyzoides	2.389
5. Alnus nepalensis	5.6
6. Amaranthus spinosus	0.309
7. Artemisia indica	4.108
8. A. sieversiana	1.865
9. Azadirachta indica	0.78
10. Berberis aristata	0.945
11. B. asiatica	0.855
12. Bergenia ciliata	0.975
13. Betula utilis	102.0
14. Calotropis gigantea	6.6
15. Caltha palustris	0.045
16. Cannabis sativa	2.338
17. Cassia sophora	2.67
18. Cedrus deodara	5.06
19. Chenopodium album	0.05
20. Datura stramonium	3.37
21. Dioscorea deltoidea	1.745
22. Ephedra gerardiana	0.125
23. Filipendula vestita	0.025
24. Fragaria nubicola	0.635
25. Girardinia palmata	1.283
26. Hippophae rhamnoides	0.05
27. Ipomoea aquatica	1.5
28. Jatropha curcas	0.06

Plant species	Quantity (ton)
29. Juglans regia	65.1
30. Malva verticillata	0.21
31. Mentha longifolia	0.305
32. Nardostachys grandiflora	1.0
33. Picea smithiana	3.48
34. Pinus roxburghii	2.88
35. P. wallichiana	17.205
36. Plantago major	1.855
37. Polygonum molle	1.135
38. Populus ciliata	1.85
39. Potentilla fulgens	1.435
40. Prinsepia utilis	2.7
41. Rheum australe	9.2
42. Rhododendron anthopogon	0.1
43. R arboreum	316.22
44. R. campanulatum	2.55
45. Rosa macrophylla	0.09
46. R. sericea	0.135
47. Rumex nepalensis	3.04
48. Salix babylonica	1.78
49. Salvia moorcroftiana	0.2
50. Skimmia laureola	0.9
51. Solanum xanthocarpum	1.35
52. Swertia chirayita	1.038
53. Thalictrum foliolosum	0.025
54. Urtica dioica	1.42
55. Valeriana jatamansi	0.5
56. Verbascum thapsus	0.07
57. Viburnum cotinifolium	0.12
58. V. erubescens	0.07

Table 4

List of medicinal and aromatic plants and the corresponding quantity that has been proposed to be harvested from the study area (Gandaki and Dhaulagiri zones I; Bhattarai et al., 1985)

Plant species	Quantity (ton)
1. Abies spectabilis	23.2
2. Acorus calamus	5.3
3. Adhatoda vasica	4.1
4. Agave americana	2.0
5. Alnus nepalensis	38.5
6. Artemisia dubia	62.3
7. Berberis aristata	44.2
8. B. asiatica	18.75
9. B. wallichiana	14.4
10. Bergenia ciliata	2.9
11. Betula utilis	390.0
12. Butea minor	5.05
13. Calotropis gigantea	0.7
14. Cannabis sativa	17.8
15. Cassia sophora	9.6
16. C. tora	12.65
17. Centella asiatica	8.88
18. Datura stramonium	8.5
19. Dioscorea bulbifera	42.0
20. D. deltoidea	8.7
21. Ephedra gerardiana	10.6
22. Fragaria nubicola	12.85
23. Girardiana palmata	0.405
24. Hippophae rhamnoides	0.125
25. Jatropha curcas	3.65
26. Juglans regia	56.0
27. Juniperus indica	170.0
28. Lycopodium clavatum	0.5

Plant species	Quantity (ton)
29. Mahonia napaulensis	0.335
30. Mallotus philippense	0.6
31. Paris polyphylla	3.9
32. Pinus roxburghii	0.705
33. P. wallichiana	17.1
34. Plantago major	4.05
35. Polygonum molle	0.15
36. Populus ciliata	10.0
37. Potentilla fulgens	11.7
38. Primula strumosa	0.01
39. Prinsepia utilis	4.05
40. Rheum australe	2.0
41. Rhododendron anthopogon	1.5
42. R. arboreum	612.5
43. R. barbatum	110.0
44. R. campanulatum	290.0
45. R. setosum	22.0
46. Rosa macrophylla	0.15
47. R. sericea	3.75
48. Rumex nepalensis	45.5
49. Salix babylonica	0.4
50. Solanum xanthocarpum	0.65
51. Taraxacum officinale	0.77
52. Urtica dioica	17.98
53. Viburnum cotinifolium	1.73
54. Zizyphus mauritiana	0.1

Table 5

List of medicinal and aromatic plants and the corresponding quantity that has been proposed to be harvested from the study area (Gandaki and Dhaulagiri zones II; Joshi et al., 1985)

Plant species	Quantity (ton)
1. Abies spectabilis	15.5
2. Adhatoda vasica	17.0
3. Artemisia dubia	13.5
4. Berberis aristata	10.5
5. B. asiatica	11.25
6. B. wallichiana	6.0
7. Boenninghausenia albiflora	0.8
8. Cannabis sativa	1.7
9. Cassia sophora	3.15
10. C. tora	4.995
11. Centella asiatica	1.75
12. Dioscorea bulbifera	5.8
13. D. deltoidea	1.5
14. Ephedra gerardiana	7.3
15. Gaultheria fragrantissima	1.5
16. Girardinia palmata	4.25
17. Hippophae rhamnoides	4.7
18. Juniperus indica	0.1
19. Mahonia napaulensis	0.65
20. Mallotus philippense	0.01
21. Parnassia nubicola	0.35
22. Phyllanthus emblica	0.5
23. Pinus roxburghii	1.55
24. P. wallichiana	3.0
25. Plantago major	4.45

Plant species	Quantity (ton)
26. Populus ciliata	4.0
27. Potentilla fulgens	0.8
28. Prinsepia utilis	2.8
29. Rhododendron anthopogon	50.0
30. R. arboreum	510?0
31. R. barbatum	180.0
32. R. campanulatum	15.0
33. Rosa sericea	0.5
34. Rubia manjith	0.1
35. Rumex nepalensis	11.5
36. Solanum xanthocarpum	1.55
37. Taraxacum officinale	0.69
38. Thymus serphyllum	1.25
39. Urtica dioica	4.6
40. Valeriana hardwickii	0.4
41. V. jatamansi	0.05
42. Viburnum erubescens	1.85
43. Zanthoxylum armatum	1.0

Table 6

List of medicinal and aromatic plants and the corresponding quantity that has been proposed to be harvested from the study area (Bagmati zone I & II; Bhattarai, 1986)

Plant species	Quantity (ton)
11. Abies spectabilis	31.6
2. Adhatoda vasica	11.5
3. Artemisia dubia	78.5
4. Berberis aristata	4.5
5. B. asiatica	9.6
6. Bergenia ciliata	0.8
7. Centella asiatica	6.7
8. Dioscorea deltoidea	4,6
9. Ephedra gerardiana	0.5
10. Gentiana prolata	0.3
11. Hippophae rhamnoides	4.0
12. Juniperus recurva	20.5
13. Lycopodium clavatum	1.0
14. Mahonia napaulensis	3.1
15. Mallotus philippense	0.8
16. Pinus roxburghii	1.0
17. P. wallichiana	10.4
18. Plantago major	11.0
19. Potentilla fulgens	6.5
20. Rheum australe	0.6
21. Rosa macrophylla	0.4
22 R. sericea	2.8
23. Rubia manjith	0.5
24. Rumex nepalensis	19.0
25. Solanum aculeatissimum	4.9

Plant species	Quantity (ton)
26. Swertia chirayita	2.0
27. Taraxacum officinalis	0.3
28. Verbascum thapsus	0.01
29. Viburnum erubescens	8.5
30. Zanthoxylum armatum	2.5

Table 7

List of medicinal and aromatic plants and the corresponding quantity that has been proposed to be harvested from the study area (Dolpa Region I; Bhattarai, 1987)

	Plant species	Quantity (ton)
1.	Abies spectabilis	20.15
2.	Acorus calamus	1.95
3.	Artemisia dubia	2.5
4.	Asparagus racemosus	0.05
5.	Berberis aristata	3.9
6.	B. asiatica	1.2
7.	Bergenia ciliata	1.7
8.	Cedrus deodara	1.0
9.	Centella asiatica	0.65
10.	Dioscorea bulbifera	4.6
11.	Ephedra intermedia	1.2
12.	Juniperus indica	0.45
13.	Justicia adhatoda	9.5
14.	Picea smithiana	18.95
15.	Pinus roxburghii	35.7
16.	P. wallichiana	49.5
17.	Plantago major	1.08
18.	Podophyllum hexandrum	0.55
19.	Potentilla fulgens	0.55
20.	Prinsepia utilis	5.3
21.	Rheum australe	8.3
22.	Taraxacum officinale	0.15
23.	Thymus serphyllum	0.43

Table 8

List of medicinal and aromatic plants and the corresponding quantity that has been proposed to be harvested from the study area (Ramechhap and Dolakha districts; Bhattarai, 1988)

Plant species	Quantity (ton)
1. Abies spectabilis	2.8
2. Acorus calamus	0.05
3. Adhatoda vasica	1.0
4. Artemisia dubia	7.7
5. Berberis aristata	2.0
6. B. asiatica	11.5
7. Centella asiatica	0.75
8. Gaultheria fragrantissima	46.0
9. Lycopodium clavatum	0.65
10. Phyllanthus parvifolius	0.5
11. Pinus roxburghii	15.65
12. Potentilla fulgens	0.9

Table 9

Overall quantity of medicinal herbs and essential oils from all the previous reports combined.

	Plant species	Quantity (ton)
1.	Abies spectabilis	117.030 (E. oil)
2.	Acorus calamus	8.95
3.	Adhatoda vasica	43.735
4.	Agave americana	2.35
5.	Ageratum conyzoides	2.38
6.	Alnus nepalensis	44.1
7.	Amaranthus spinosus	0.30
8.	Artemisia dubia	171.5
9.	A. indica	4.850
10.	A. sieversiana	2.46
11.	Asparagus racemosus	0.05
12.	Azadirachta indica	0.78
13.	Berberis aristata	66.57
14.	B. asiatica	53.305
15.	B. wallichiana	20.5
16.	Bergenia ciliata	7.575
17.	Betula utilis	837.75
18.	Boenninghausenia albiflora	0.8
19.	Butea minor	5.05
20.	Calotropis gigantea	7.3
21.	Caltha palustris	0.045
22.	Cannabis sativa	21.830
23.	Cassia sophora	15.4
24.	C. tora	17.605
25.	Cedrus deodara	6.61 (E. oil)

Table 9 continued

	Plant species	Quantity (ton)
26.	Centella asiatica	18.73
27.	Chenopodium album	0.05
28.	Datura stramonium	11.87
29.	Dioscorea bulbifera	52.4
30.	D. deltoidea	26.395
31.	Dryopteris sp.	4.1
32.	Ephedra gerardiana	18.8[illegible]
33.	E. intermedia	1.[illegible]
34.	Filipendula vestita	0.05
35.	Fragaria nubicola	15.[illegible]
36.	Gaultheria fragrantissima	47.5
37.	Gentiana prolata	0.3
38.	Girardinia palmata	5.938
39.	Hedera nepalensis	0.1
40.	Hippophae rhamnoides	8.995
41.	Ipomoea aquatica	1.5
42.	Jatropha curcas	3.71
43.	Juglans regia	223.2
44.	Juniperus indica	245.95
45.	J. recurva	20.5
46.	Lycopodium clavatum	2.15
47.	Mahonia napaulensis	4.08
48.	Mallotus philippense	1.41
49.	Malva verticillata	0.21
50.	Mentha longifolia	1.355
51.	Nardostachys grandiflora	1.0
52.	Paris polyphylla	3.3
53.	Parnassia nubicola	0.35
54.	Phyllanthus emblica	0.5
55.	P. parvifolius	0.5

Table 9 continued

	Plant species	Quantity (ton)
56.	Picea smithiana	28.35 (E. oil)
57.	Pinus roxburghii	57.485 (E. oil)
58.	P. wallichiana	121.405 (E. oil)
59.	Plantago major	22.435
60.	Podophyllum hexandrum	0.55
61.	Polygonum molle	1.295
62.	Populus ciliata	29.35
63.	Potentilla fulgens	29.205
64.	Primula strumosa	0.06
65.	Prinsepia utilis	19.7
66.	Rheum australe	26.1
67.	Rhododendron anthopogon	51.6
68.	R. arboreum	1439.72
69.	R. barbatum	290.0
70.	R. campanulatum	307.55
71.	R. setosum	32.0
72.	Rosa macrophylla	0.765
73.	R. sericea	10.335
74.	Rubia manjith	0.6
75.	Rumex nepalensis	83.335
76.	Salix babylonica	2.24
77.	Salvia moorcroftiana	0.8
78.	Sambucus hookerii	0.35
79.	Skimmia laureola	0.9
80.	Solanum aculeatissimum	4.9
81.	S. xanthocarpum	3.59
82.	Swertia chirayita	5.138
83.	Taraxacum officinale	1.335
84.	Thalictrum foliolosum	0.22

Table 9 continued

	Plant species	Quantity (ton)
85.	Thymus serphyllum	3.73
86.	Tussilago farfara	1.25
87.	Urtica dioica	24.1
88.	Valeriana hardwickii	0.4
89.	Valeriana jatamansi	0.55
90.	Verbascum thapsus	0.115
91.	Viburnum cotinifolium	7.99
92.	V. erubescens	10.67
93.	Zanthoxylum armatum	3.5
94.	Zizyphus mauritiana	0.1

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Bhattarai, N.K., Pradhan, B. and Bojor, O. 1985. Economic mapping in Gandaki and Dhaulagiri zones I. UNIDO/ Department of Medicinal Plants, Kathmandu. (Mimeograph).

Bojor, O., Joshi, D.P. and Bhattarai, N.K. 1984. Economic mapping in Jumla and adjoining areas. UNIDO/Department of Medicinal Plants, Kathmandu. (Mimeograph).

Dhoubhadel, S.P. 1982. Importance of Natural Products Research in Nepal. Proc. First National Science and Tech. Cong., NCST, Kathmandu. pp. 19-20.

Joshi, D.P., Bhattarai, N.K. and Pradhan, N. 1985. Economic mapping in Gandaki and Dhaulagiri zones II. Botanical Survey and Herbarium, Department of Medicinal Plants, Kathmandu. (Mimeograph).

20.2 SUMMARY

1. A quantitative estimation of harvestable quantities of 94 economically important medicinal and aromatic plants in parts of 19 districts representing 7 zones of the country along the route shown in Table 1 has been carried out using quadrant method during the period 1984-88. This work of economic mapping of medicinal and aromatic plants has been presented in 7 reports. The total harvestable quantity of crude medicinal herbs and essential oils along the route followed are estimated to be 4455.175 ton and 3 9.88 ton respectively (Table 9).

2. Among the studied areas, Jumla region appears to be rich in the coniferous population and Thymus serphyllum, Acorus calamus, Rheum australe, Dioscorea deltoidea and Prinsepia utilis (Table 2 & 3). Dhorpatan region has a good population of Abies spectabilis, Pinus wallichiana, Dioscorea bulbifera, Juniperus indica and Ephedra gerardiana (Table 4 & 5). The Langtang-Gosaikunda region was found to be rich in Abies spectabiiis and Juniperus recurva population (Table 6). Dolpa region is rich in Ephedra intermedia, Rheum australe, Podophyllum hexandrum and conifers like Abies spectabilis, Picea smithiana, Pinus roxburghii and Pinus wallichiana (Table 7).

3. The rain-shadow and comparatively less fertile regions of the present study area, such as the northern part of Dolpa district provide ample opportunity to divert the local inhabitants towards cultivating important medicinal plants like Rheum australe, Nardostachys grandiflora and Podophyllum hexandrum in the barren lands, suited to the local climatic conditions and also having increased export potentiality.

20.3 RECOMMENDATIONS

1. Before collection of medicinal and aromatic plants, the area should ne mapped. This can be done by the Department of Medicinal Plants and the findings should be handed over to to the concerned District Forest Controller Offices.

2. The economic mapping activity should be conducted at least twice in each locality in different seasons in order to obtain data on maximum number of economically useful species.

3. The Department of Medicinal Plants should regularly arrange short-term training programmes for the Forest Officers of all districts. They should be trained regarding the controlled and planned harvest of different medicinal herbs, and their drying and storage.

4. The Department of Medicinal Plants should provide various information on techniques of collection of different medicinal herbs, their proper drying and storage techniques to the District Forest Controller Offices.

5. Collection of medicinal herbs should be permitted by the District Forest Controller Offices and the permission should be based upon the available plant resource of the area.

6. The Department of Medicinal Plants or the Herbs Production and Processing Company can provide at least one portable type of distillation unit so that considerable amounts of leaf-tops from the standing conifers and also the whole leaf-tops from the trees cut down for some other purpose can be used to extract the essential oil along with the cost/benefit ratio study as well.

7. Based upon the findings of economic mapping, introduction of useful plants in the possible localities should be encouraged. In this concern, Maharigaon and Tatopani regions of Jumla district appear suitable for the cultivation of Crocus sativus.

8. The local people should be provided with the primary knowledge about the important medicinal herbs growing in their surroundings so that no valuable medicinal plant be destroyed due to their ignorance.

9. Attempts should be forewarded towards gradually replacing the export of crude medicinal herbs by the processed or semi-processed products.

4. Perspective

1. The project is in an area of scientific, socio-cultural and health sector importance and has the potential of contributing to the economic and industrial development of Nepal, and is thus of great relevance.
2. The project was initiated to strengthen the R & D capability in Nepal for processing and utilization of plant products and to make better use of its Ayurvedic Drugs.
3. In the long run it is only through development of R & D strength and establishing a self-reliant base of technology that a country can become self-reliant.
4. The Royal Drugs Research Laboratory occupies a key position in the field of drugs and pharmaceuticals and plant products research in Nepal. It is the only laboratory which was established for and has the capability to do this integrated R & D work covering a number of desciplines. It has played an important institutional building role. It helped to establish the Royal Drugs Ltd. in 1971, the main pharmaceutical industry unit in Nepal. It helped to formulate the Drug Administration established in 1979. It helped to establish the modern herb processing factory The Herbs Production and Processing Co. Ltd in 1980. RDRL has close links with these and other institutions connected with research on plants and their utilisation and thus is the focal institution for R & D in this area.
5. Through this UNIDO project NEP/80/003 there is now established:
   - good infrastructure of equipment & essential facilities;
   - staff has been trained in the modern methodology and techniques of most of the cognate desciplines, which has been supplemented by the inputs of the experts in some of the crucial areas by hands-on-the-job experience in RDRL;

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- with project based functioning of R & D programmes , a scientific management structure has been created which is conducive to better outputs in multidesciplinary applied research;
- inter-institutional links have been established with some organisations likely to utilize the R & D outputs of RDRL in the form of Joint Co-ordination Committees.

6. The major equipment of the Pilot Plant at Godavari, though a nucleus of it existed as a part of RDRL of Thapathali, has been established primarily by the support provided by this project. It is now fully installed. The expert's inputs have been very valuable in the operationalisation of the equipment. As is pointed out in the report of the expert appended with this report (Annex 4) some design deficiencies have been noted due to which some equipments will need modifications alterations to make it oprational. Though this equipment was supplied at the instance of RDRL order and also accepted by them, but a reputed company like Tournaire should advise the Labs in developing countries like Nepal better, and supply equipment which is truly multipurpose and flexible in operation. It is suggested that: (a) UNIDO should point this out to Tournaire, and use its good offices to make them agree to modify the equipment as necessary to make it operational. Failing which the modifications will be done in Kathmandu but this will need additional funds approx. US $ 10,000.00. (b) In future when equipment of this magnitude and cost is imported in the contract of supply there should be a clause for on the spot inspection by the host laboratory scientists. (c) Kathmandu has good equipment fabrication facility, and RDRL should have considered getting some of the equipment such as percolators locally fabricated, which would give valuable experience to local fabricators and saved RDRL some money.

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Nothwithstanding what has been said above the equipment that is in operation provides a unique pilot plant facility in Nepal, and is amongst the best available any where in this part of the world. It would be useful to establish suitable mechanisms for various types of sponsored research projects so that optimal use is made of this excellent facility and the equipment is kept fully used and occupied.

7. Thus as a result of the inputs provided by UNIDO is the project the basic infra-structure and organisation have been created in RDRL (& the pilot plant) to achieve the objectives set for the project. The project has the right perspective and the programmes are moving in the right direction, and some hard outputs as indicated in the body of the report are already visible. And if the momentum could be maintained, more outputs will follow. The main challenge is how this direction and momentum should be maintained, and there is role both of the UNIDO and HMG's/RDRL in this.

8. UNIDO must ensure that all the gains made through its investment of funds and the time and the effort of the experts are consolidated and get enmeshed fully into an abiding structure, and lead to the establishment of a self-reliant technology base. For UNIDO to withdraw suddenly when the present project comes to an end in the end of July will create a vacuum particularly in the Pilot plant Laboratory which has been made operational just recently. The bigger problem is the lack of funds from normal Govt. channels due to financial cuts, financial stringency and freezing of posts. UNIDO will thus have to think of some alternative to meet this situation and to provide support to the project on a continuing though gradually diminishing basis. One way and perhaps the ideal are would be to continue the project for 2 years more for s very specified projects/components. In the form of a Phasing-out

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Grant, of about $ 125000 and $ 100,000 for some essential chemicals, spare parts, and equipment and many selective study tours or conference deputation. The main point is that continuing support for a few more years is necessary to consolidate the gains of the project inputs. It takes time to build up scientific traditions and culture in an institution, particularly in developing countries, and now when the movement of the project in the right directions is taking place it is best to help to consolidate it.

9. For RDRL, it is most important that its scientific staff must develop self-confidence that: "we can do it"; that: "nobody from outside can come and do the job for us,: we are ourselves competent to do the job well". To this there is no short except to go the hard way of hard and patient work. The senior staff must provide the leadership for this. This will create the self-reliant outlook which is most essential for the laboratory's output. This is the challenge which RDRL has to meet. The scientific staff of RDRL is competent by any standard but needs to develop the self-confidence. They must also be accountable and ansurable for the confidence reposed in them. The phasing-out period will be for RDRL's staff to show its mettle and strenqth.

10. HMG must step up its support for the laboratory now that UNIDO's support is coming to an end, so that the laboratory can maintain its dimension of activity and even expand to serve its objectives even better.Some of the facilities created at RDRL this project are extremly valuable for Nepal. These include the Animal House and Instrumentation Section (and Glass Blowing Section when it is fully operational). Many other laboratories in Nepal, would need these facilities;. These facilities are not easy to duplicate. It is suggested that with further support these facilities should in enlarged to serve as National Facilities. Users committees may in formed to work out the structure and mode of operations if these sections to serve as National facilities.

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11. Research Advisor of Committee. It is suggested that for evaluating the scientific work of the institute Research Advisory Committee should be formed, with experts drawn from University, Medical College & Industry & other user agencies who should review and monitor the work of the Institute, advise which projects should be continued, and those which have not made good progress should be dropped, and also suggest new projects. Funding would get related to the projects and will introduce accountability for the scientists. World experience has shown that periodic External review is most necessary for the scientific institutes to bring in fresh ideas, remove bias and vested interest in research projects.

12. Inputs needed

The Pilot Plant Laboratory will need additional staff to function efficiently and to be able to generate the much needed process design & engineering data. It should have the following additional staff immediately:

1. Chemical Engineers 2
2. Analytical Chemist for Process Control Lab. 1
3. Boiler Asstt. trained 1

13. The Drug Quality Control Analysis service provided by this RDRL has been very valuable for the Department of Drug Administration. The analysis carried out so far include only the conventional pharmacopeal test of dissolution, disintegration etc. Many products now require bioavailability studies. F rther now that local pharmaceutical industry units are being established it is important to demonstrate the equivalance (including bioequivalence) of products of local industry with the imported products. This will create confidance in the products of local industry. These tests of bioavailability and bioequivalance will require upgrading of the Drug Anslysis capability. It is suggested that Dr. P.M. Adhikary, Chief, Royal Drug Research Lab. be deputed to a period of 3 weeks to United Kingdom & Sweden to make a special study of this Government and Private Industry Drug Control Laboratories to know the latest developments in the field of

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Bioequivalance and Bioavailable studies, and help to upgrade the Drug Analysis Laboratory at RDRL to include these analysis. This name is suggested in consultation with Dr. S.B. Malla. As the drug analysis services are becoming more and more specialised, the cost of these services is going up. Although so far RDRL has been providing these services without any charge to the DDA, it is suggested that a suitable charge should be levied for these services to DDA, who could in turn charge the industry or chemists who samples are analysed and tested.

14. The freeing of all fresh appointments and new posts, inter-departmental transfers irrespective of descipline specialisation have also adversly affected the project execution. Drug development does need a minimal viable staff component to be able to cover all the stages of drug development from isolation of the product, pharmacological evaluation to developing suitable pharmeceutical formulation; preclinical toxicity, and human safety studies. With the freeze on new posts it was not possible to have staff who could be trained in some of the specialised pharmacological and preclinical toxicology testing techniques, which has left a gap in the capability building in new drug development programme. It is suggested that at least four more scientists with an equal number of technicians should be added in the Biology Division, with at least one of them being a Phathologist, and only then it will be possible to carry out any meaningful pharmacological and toxicological evaluation of the products. As it is there are many jobs to be done and very few staff. In the long run it would also be useful to create a group in fermentation technology as this area is of much relevance in the context of Nepal's industrial development. A note highlighting the importance of this area for Nepal & the facility already available at RDRL is given as Annex 7.

15. The lack of funds has affected the library very adversely. Library in any institution is its nerve centre and must get the core periodicals and annual publications. Although RDRL has a reasonably good collection of old books and journals, but due to lack of funds it is getting practically no current

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periodicals except abst. list and very few Annual Reviews, Monographs or books. The long terms effects of this depletion of funds to the Library will be catastrophic for the laboratory scientific staff when they do not know what is happening in science in other countries. A National Library Exchange for Science Libraries may be evolved by which the institutions can share and exchange scientific journals and books; to begin with a catalog of all the journals available and currently subscribed to by the various science institutions in Kathmandu may be prepared.

16. One of the best ways to ensure prompt utilisation of R & D outputs of a research laboratory is to encourage sponsored research for the user agencies. In the present climate of dwindling budgets and financial stringencies sponsored research can also provide the much needed additional funds. However, in Nepal according to existing financial rules any funds received from outside agencies go to general Govt. revenue and can not be used by the laboratory even if the laboratory has to spend extra funds to carryout the sponsored research. This does not provide any incentive for the laboratory or the scientists to do the extra work. There is need to reexamine the rules, and to make a provision so that: (a) the funds earned by the laboratory by doing sponsored research and providing special services should be retained by the laboratory; (b) the money earned by the laboratory as consultation fee or as royalty from new processes or products developed should be shared by the Govt., the laboratory and the scientists responsible for the work. This point was discussed at length in the TPR meeting held on June 16, 1987, and the Chairman & Secretary, Ministry of Forest & Soil Conservation agreed to the principle of the laboratory being allowed to keep at least a part of the funds earned. A concrete proposal in this regards was submitted to HMG in October 1987. This case should be seriously taken up and applied in the R & D institution for creating confidence in the scientific

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community & to generate self-confidence in the scientists which will help in strengthening of RDRL.

17. Another factor which often delays the speedy implementation of the project schedule is the need for HMG's separate permission for each component of the programme though the overall programme is already accepted in principle by UNIDO & HMG as both are signatories to the Project. There should be no need to obtain HMG's fresh sanction for each component so far as there is no deviation from the project document and it should be left entirely to the Project Manager (or Management) to execute the programme in all its details.

Equipment procurred and delivered to NDRL, Dept. of Medicinal Plants

Status as at 31/8/83

Sl. No. (1)	P.O. No. (2)	Description (3)	Amount in US$ (4)	Remarks (5)
1.	15-2-K0295	Grass Model 7-3P-24.5 Polygraph.	17,217	Equipment received in good condition & delivered to NDRL.
2.	15-2-K0835	Diesel Engine Generator Model: as 40 M - with push button start, facility for remote control start, fuel tank, bonnet wheels & all necessary pipes.	9,055	" "
3.	15-2-K15C4	Pallet Trucks (Venicles) qty: 2 nos.	1,324	" "
4.	15-3-K0362	Airconditioners Hitachi; Model: RA-2140 bh. qty: 5 nos.	4,650	" "
5.	15-3-K0325	Olympus Microscope Model CGC Bi-i. qty: 1	961	" "
6.	15-3-R4C32	Pharmacological Reviews.	1,070	" "
7.	15-3-K0326	BFB-220uk Balance Analytical Mettler R20 Range 160g; BFR-330ek Balance Top Loading Mettler e2CCO; SCP/2CO-010vd Shaker/Stirrer Spimix.	3,129	" "
8.	15-3-K0413	BRS 312Trincular Microscope (Halegen); PM 10 35M Photomicrographic eyepiece; SZ-3 Stereoscopic Zooak 3; X-CE Trans-illuminating base; VZ-FL Light and transformer CK. total qty: 11 nos.	5,457	" "
		Sub Total:-	42,754	

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Annex - 1

(1)	(2)	(3)	(4)	(5)
			42,764	
9.	15-3-N0422	Technical Paper 425 A4; Technical Paper 526; Technical Paper 563.	112	Goods received and delivered to RDRL.
10.	15-3-R4042	Subscription of Books. qty: - Lot.	4,612	Books delivered to RDRL.
11.	15-3-N0478	Electronic Microbalance M-3 qty: one.	4,232	Equipment received and delivered to RDRL.
12.	15-3-N0494	Water Bi-Distillation Apparatus, one cap. 3 1/h, 220 Volts/50Hz; one Cell Homogenizer; 1 protective metal beaker, one set of spare parts for water still exactly as per KK No. 421-101 etc.	4,342	Equipment received and delivered to RDRL.
13.	15-3-N0490	Lab. Equipments from Karl Kolb GmbH + Co. KG, FRG.	3,592	Equipment received and delivered to RDRL.
14.	15-3-N0569	Diesel Generator Model: [illegible]-73, 73 KVA, 53.4 KW, 400/230V, 3 Phase, 4 wire 50 Hz complete with automatic transfer device with panel.	10,629	Equipment received and delivered to RDRL.
15.	15-3-D0699	Modular Fermenter with accessories.	9,681	" "
16.	15-3-D0726	Capsule Filler Model bb-6/5; accessories forprocessing capsule sizes nos. 1 & 2 with spare parts; Capsule filter Model bb-3/8; accessories for processing with spare parts etc.	12,900	" "
		Sub Total:-	98,964	

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(1)	(2)	(3)	(4)	(5)
			98,964	
17.	15-3-00734	Versatile Spray Dryer Type P-6.3 complete with accessories.	39,963	Equipment received and delivered to RDAL/CMP.
18.	15-3-0730	Hammer Mill 315-100 Large size complete as 220/380V - 50HZ - 150CW - 3 Phase. Medium Jaw Crusher 715/910 with spareparts.	10,109	" "
		Sub Total 3:-	149,036	

Sl. No.	P.O. No.	Description/Supplier	Amount in US$.	Remarks
19.	15-2-M1293	48K Apple II Computer with accessories and spare parts. M/S. Personal Computers, 213, 220/225, Bishopsgate, London EC2M 4JS, U.K.	3,966	Equipment with accessories and spare parts received and delivered to ADAL in good condition.
20.	15-2-M0367	25991 Model 6000 solvent delivery with accessories and spareparts (HPLC). M/S. Waters Associates Pty. Ltd., #67/#91 Goldhill Centre Thomson Rd, Singapore - 1130.	27,245	" "
21.	15-2-KC513	Steamax steam Boiler Model SC20, capable of generating 1500 Kgs/hr of steam from water at 30°C with accessories and spare parts. M/S. Thermax Pte. Ltd., Operating 1, Stg. 1/111/334, 1010 Vienna, Austria.	DD Rs. 367,210	" "

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Equipments procurred and delivered to RDRL, Dept. of Medicinal Plants

Status as at 31/8/98

Sl. No. (1)	P.O. No. (2)	Description/Supplier (3)	Amount in DEM (4)	Sub Total (5)	Remarks (6)
22.	15-6-20297	Aldrich Library of FT-IR Spectra, 2 Vol. FT-IR Peak Search Data Base and software for Apple IIE, IIC & II Plus Computers (212774-4). M/S. Aldrich Chemicals Co., Milwaukee, Wisconsin 53201, USA.	1,008	1,008	Equipment received in good condition and delivered to RDRL.
23.	15-6-20296	Asbestos Gloves, having flannel linking 14" size. Asbestos Rope with different dia. M/S. United Asbestos MFG. Co., 33/35 Netaji Subash Road, Calcutta - 700001, India.	350	1,358	" "
24.	15-6-20279	Laboratory Supplies. M/S. Karl Kolb & Co, KG., 6072, Dreich, FRG.	3,746	5,104	" "
25.	15-6-20319	3M Precision 3 inches Floopy Diskettes, single side double density hard sectored 32 hubs. M/S. M.J.M. Ges Rossauer Lande A-1090, Wien, Austria.	313	5,417	" "
26.	15-6-20292	Spare parts of Varian EM360-NMR. M/S. Varian AG, Steinhausertrasse, CH-6300, Zug, Switzerland.	1,551	6,968	" "
27.	15-6-20362	8060A, Digital Multimeter, High Voltage 35RF High frequency probe, 500 MHz. M/S. John Fluke Int'nal Corp., P.O. Box-C9090, Everett, USA.	691	7,659	" "
28.	15-6-20493	Electronic Components & accessories. M/S. RS Components Ltd., Corby Northants, NN179RS, U.K.	1,026	8,685	" "

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Sl.No. (1)	P.O. No. (2)	Description/Supplier (3)	Amount in US$ (4)	Sub Total (5)	Remarks (6)
29.	15-6-20418	CHROMOSORB & accessories of g.l.c (gas, liquid, chromatography). M/S. ict Chemikalien, Vertriebs Ges m.b.H., Wien, Vienna, Austria.	3,944	12,529	Equipments received in good condition and delivered to RDRL. qty: 5 nos.
30.	15-6-04135	Books in lot. M/S. RS Components Ltd, P.O.Box-427, 13-17, London, U.K.	600	13,229	Books delivered to RDRL in good condition.
31.	15-6-04136	Perfume & Flavour chemicals (2 Vol. each set). M/S. Maria G. Arctander, 6665 Valley View Blvd, Las Vegas, Nevada 89118, USA.	1,165	14,394	Books delivered to RDRL in good condition. qty: 5 nos.
32.	15-6-20332	Wolf 154, Two speed power operated Hand Drill complete with chuck key and side handle, electrics 220/240V, (1-3)HZ. Wolf 3793 Blower power operated, Electronics 220/240V and optional items etc. M/S. Kennedy International Ltd., Wingston, Lancaster, LE5 1ay, U.K.	2,016	16,410	Equipment received in good condition and delivered to RDRL.
33.	15-6-20340	LCR Meter 4261A, TTL/DTL/RTL, Logic Comparator, Logic Probe, Logic Pulser, Family Current Tracer. M/S. Hewlert-Packared Co. Cal. USA.	4,180	20,590	Equipment delivered to RDRL in Good condition.
34.	15-6-20341	Oscillascope 2236 component kit, power module, Fctn Generator, Data Analyser, Plug etc. M/S. Tektronicx Inc. Baverton, Oregon - 97075, USA.	21,481	42,071	Equipment delivered to RDRL in good condition.

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(1)	(2)	(3)	(4)	(5)	(6)
35.	15-6-30526	General Purpose Tapered Reamer, Electronic Cleaner/ electrically conductive silver component/cooler/particles remover. M/S. Tendy Corporation, Bilston Rd, Wednesbury, West Midlands, U.K.	416	42,487	Equipment not as yet arrived. Cable already sent to UNIDO, Vienna for follow-up action. with supplier.
36.	15-6-30814	Khosla Model 14.3. Single Cylinder, Single stage Air Compressor. M/S. K.G. Khosla Compressors Ltd, Deshbandhu Gupta Rd, New Delhi.	637	43,124	Equipment received in good condition and delivered to RDRL. qty: one unit.
37.	LPA. Vide Cable 04232 sent from HQs	Animal Cages. M/S. Vishnu Traders, Khorki, India.	2,303	45,927	Goods delivered to RDRL in good condition.
38.	15-6-30694	Multimeter Digital Handled Model MK2102. M/S. Hindustan Instruments Ltd., 503, Vishal Bhavan, Nehru Rd, New Delhi - 110019, India.	245	46,172	Equipment delivered to RDRL in good condition. qty: one unit.
39.	15-6-30694	Annealing Oven, Electrically operated Chamber. M/S. Therelec Furnances Pvt Ltd., A/131 Rd No. 23, Wagle Industrial Estate, Thane - 400 604 MH, Bombay.	5,400	52,172	Equipment received in good condition and delivered to RDRL. qty: one unit.
40.	15-6-30952	Lab. Equipments. M/S. Labortechnic GMBH + Co. KG., Eichkoppelweg - 101, D-2300, Kiel, Kronsnagen, FRG.	20,976	73,098	Equipment delivered to RDRL in good condition. qty: Lot.
41.	15-6-31379	Filter Press Stainless Steel Mounted with Pump for syrup, 40x40 cm, 250 nos, 5 filter plates.	-	-	Equipment delivered to RDRL in good condition. The equipment is supplied under item no. 5 of P.O.

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(1)	(2)	(3)	(4)	(5)	(6)
43.	15-6-31379	Mixing Tank 33 (Capacity 100 litres) jacketed for hot water heating with cover and agitator with one necessary spareparts.	-	-	Equipment received but not provided with accessories, so the mixing tank returned to vendor for replacement delivery. qty: one unit.
43.	"	Coating Pan 16 in. dia. complete with hot air blower BCP 2.	-	-	Goods delivered to RDRL in good condition.
44.	"	D33 Rotary Tablet Machine. (10 Tons Pressive) complete with Disc and Punches (20 sets 5/8, 1/2, 7/16, 13/32, 3/8, 5/16 in bevelled punches; 1/2, 7/16, 13/32, 5/16 in shallow concave punches), Hydraulic Pressure indicator reduster and dust extraction unit (8 punches) and accessories. M/S. L+T Labortechnik GmbH + Co.KG, Eichkoppelweg 101, D-2300 Kiel, Kronshagen, FRG. (Attn: Mr. K. Schmidt).	33,416	161,314	Equipment received in good condition and delivered to RDRL.
45.	15-6-31331	Planetary Stirring, Kneading and Whisking Machine, Electro Rapid type MR 60 with an infinitely variable speed gear for many speeds and electric motor three-phase current 380/220 volts, 50 Cycles, 1 bowl Scraper, cable and plug. M/S. F. Herbst + Co., Dykhofstrasse 7, Postfach 100 638, 4040 Neuss, FRG.	9,550	171,064	Equipment delivered to RDRL in good condition.

(1)	(2)	(3)	(4)	(5)	(5)
[illegible]	15-6-21332	Tablet Hardness Tester - Two Tablet Fribrialator - One Tablet Fribriality and Impact Testing Apparatus - One. Disintegration Testing Machine - one. M/S. Erweka Apparatebau GmbH., P.O. Box - 1253, Ottostrasse 80-22 D-6056., Heusenstamm, FRG.	5,795	175,359	Equipment received partly in good condition and delivered to RDRL. Rest of the accessories qty: 5 nos. not yet received as per P.O., cable already sent to MGs. requesting supply of the above items from vendor.
[illegible]	15-6-21320	Nordenmatic 500 M Tube Filling and Closing Machine with equipment as per attached copy of specification sheet no, 36/333A. Power Supply 38/220V, 50 HZ and 380V, 50 HZ, 3 Phase. M/S. Nordan AB Box - 345, S - 391 28 Kalmar, Sweden (Attn: Mr. L. Ljung).	43,166	220,025	Equipment received in good condition and delivered to RDRL.
[illegible]	FPO No. 001578	Electronic Components. M/S. India Radio & Electronics Corporation. 13-14, Rani Building, Prathana Samaj, Bombay - 400 004, India.	795	220,329	Goods received in good condition and delivered to RDRL. qty: Lot.
[illegible]	15-3-20208	Biological Research Apparatus. M/S. OGO BASILE, Viale G. Borghi, 43 21025 Comerio - Varese, Italy.	1,344	229,364	Equipment received in good condition and delivered to RDRL. qty: 4 nos.
[illegible]	FPO No. 001577	Techno Histometer & Techno Cook's Pole Climbing Response Apparatus with accessories. M/S. The Techno Electronics, Lalbagh, Lucknow - 226001, India.	1,145	230,509	Equipment still awaiting from the supplier

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GLASS BLOWING EQUIPMENT

Status as at 7/7/88

Sl. No.	P.O. No.	Description/Supplier	Amount in DM	Remarks
51.	15-6-20396	Asbestos Rope, 0.3 mm, 0.6 mm, 2. mm, 3 mm. size: 1Kg. each. M/S. United Asbestos Mfg. Co., 63/65, Netaji Subash Road, Calcutta - 700 001.		As. ropes delivered to RDRL in good condition.
52.	"	Asbestos Gloves having flannel linking 14" size. qty. 6 nos. Vendor's address as above.	350 (inleluding price of As. rope).	As. Gloves received and delivered to RDRL in good condition.
53.	15-6-20338	Vernier Caliper for measurement M/S. Kennedy International Ltd., Wigston, Lancester, U.K.	747	Equipment delivered to RDRL in good condition.
54.	15-6-20434	Annealing Oven, Chamber size 24" x 24" x 24". Electric Furnace having ganthelwire. Max. Temp. 1000°C with auto temp. controller. M/S. Therelic Furnaces Pvt. Ltd, A/131, Wagle Industrial Estate, Thane - 400 604, Bombay, India.	4,000	Equipment received in good condition and delivered to RDRL.
55.	15-6-20952	Glass Blowing Goggles, Cydinium lenses. M/S. L+T Labortechnik GmbH + CoKG. Eichkoppelweg 101, D - 2300 Kiel, Kronshagen, FRG.	(1,271 DM)	Goggles qty. 12 nos received in good condition and delivered to RDRL.
56.	15-6-20814	Air Compressor, 4 Gallon capacity 3 phase, 1HP motor safty valve, automatic pressure switch. M/S. KG Khosla Compressors, 1, Deshbandu Gupta Road, New Delhi.	637	Equipment received in good condition and delivered to RDRL.

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Sl. No.	P.O. No.	Description/Supplier	Amount in US$	Remarks
57.	15-7-21060	Blast Burner, Gun-type, mixed gas feed, with 5 interchangeable jets L+T No. 125/2PS. M/S. LABORTECHNIK GmbH + CO. KG Eichkoppelweg 10 D-2300 Kiel-Kronshagan, FRG.		Equipment delivered to RDRL in good condition. Qty: 1 no.
58.	"	Blast Burner with three stopcocks for Gas/Air/Oxygen L+T No. 103 PSL.		Equipment delivered to RDRL in good condition. qty: 1 no.
59.	"	Hand torch, with three stopcocks for gas + oxygen with nozzles of different sizes L+T No. 141 PSL-A.		Equipment delivered to RDRL in good condition. qty: 1 no.
60.	"	Carbon flats, special material size c 200 X 50 X 5 mm Size b - 200 X 50 X 10 mm.		Equip. delivered to RDRL in good condition. qty: 2 nos.
61.	"	Carbon Rods, non porus, (10 pcs) size 5 X 300 mm Dto., 3 X 300 mm (10 pcs).		Equip. delivered to RDRL in good condition. qty: 2 nos.
62.	"	Forceps, specially designed to work in glass blowing length 350 mm Dto., Length 300 mm.		Equip. delivered to RDRL in good condition. qty: 4 nos.
63.	"	Scoring tool, made of wood handle Dto., on heavy base with rotating disc.		Equip. delivered to RDRL in good condition. qty: 2 nos.
63.	"	Flask holders, with steel jaws light weight for flasks 100 ml. Dto., for flasks 50 ml Dto., for flasks 250 ml Dto., for flasks 500 ml Dto., for flasks 1 l Dto., for flasks 2 l Dto., for flasks 5 l		Equip. delivered to RDRL in good condition. qty: 7 nos.

Sl. No.	P.O. No.	Description/Supplier	Amount in US$	Remarks
64.	15-7-31060	Glass cutting machine, electric drivers, to cut glass tubing by using diamond cutting wheels of 300 mm dia. Complete with cooling water supply for connection to the water mains. 380 V, 3-ph.		Glass cutting wheels received in broken condition. Other equipment delivered to RDRL in good condition. qty: 1 no. with accessories.
65.	"	Glass Blowing Lathe, for shapping st. joints, stop cocks, flanges, bulbs etc. 2 jaw double check V shapebed, tools stock etc, elec. motor 220 V., A.C. 50 Hz 1-ph. 1 set of necessary accessory for above mentioned Lathe, consisting of: - key-operated three-jaw chuck - add. extension of jaws - clamping unit.		Lathe facilitated producing different types of ground joints and stop cocks double headed not provided for other purposes. Lathe: qty. one unit with other accessories delivered to RDRL in good condition. qty: 1 no. with accessories.
66.	"	Glass Grinding Machine, for grinding stopcocks, s$., joints Flanges etc. with 3 Jaw-Chuck, Heavy construction motor, 380 V, 3-phase. 3 speeds, clock wise and anticlockwise motion with reverse pedal switch. Accessories Grinding Disc for Grinding flanges etc. L+T No. 7132a/7164/7160.		Glass Grinding Machine not provided with three Jaw Chucks System and grinding Disc for surface grinding. Equipment and other accessories delivered to RDRL in good condition. qty: 1 no.
67.	"	Brass shapers, for shaping st. joints stopcocks, etc. size 3-7. Dto., size 3-10 Dto., size 3-14 Dto., size 3-19 Dto., size 3-24 Dto., size 3-29 Dto., size 3-34		Equipment delivered to RDRL in good condition. qty: 36 nos.

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Sl. No.	P.O. No.	Description/Supplier	Amount in US$	Remarks
68.	15-7-21060	Dto., size 3-40 Dto., size 3-45		Equipment delivered to RDRL in good condition. Total qty: 36 nos.
69.	"	Grinding Cones Male and Female, should have accurate angle of 1/10 degree, size 7. Dto., size 10 Dto., size 14 Dto., size 19 Dto., size 24 Dto., size 29 Dto., size 34 Dto., size 40 Dto., size 45		Equipment delivered to RDRL in good condition. Total qty: 54 nos.
70.	"	Grinding powder for grinding st., joints, mesh 120 Dto., mesh 180 Dto., mesh 320 Alternatively: Dto., mesh 300 Dto., mesh 400		Equipment delivered to RDRL in good condition. qty:25nos.
71.	"	Glass strain finder for detecting strains in Glass Blowing work. 220 volts, 50 c/s, single phase No. 90/05.		Equipment delivered to RDRL in good condition. qty: 1 no.
	"	Total Amount:-	20,287	As per UNIDO P.O. No. 15-7-21060 issued on 17 September 1987. (Field Req. No. 86/7).

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Sl. No.	P.P.O. No.	Description/Supplier	Amount in US$	Remarks
72.	CC1579	Glass Blowing Equipment - Lot M/S. Kanpur Scientific & Engg. Mfg.Co., 24/93, Azad Nagar, Kanpur - 208 002, India.	US. 53,950	Purchase Order is confirmed as per supplier's letter no. KS/UNIDO/88-89/4 dated 15 April 1988. Equipment is expected end May or June '88.

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Pilot Plant Equipment

Status as at 31/5/83

Sl. No. (1)	P.O. No. (2)	Description/Supplier (3)	Amount in US$. (4)	Date Settled (5)	Remarks (6)
73.	15-2-X0649	Percolation unit according to scheme. M/S. Tournaire S.A. B.P. 4 Plan de Grasse 06338 Grasse France. Attn: J.M. Chiocci.		16/7/83	Equipment received and delivered to RDRL in good condition. qty: one unit.
74.	"	3-stage mixer-settler according to flow sheet CS 254.		"	" "
75.	"	Concentration units under vacuum type 507.		"	Equipment received and delivered to RDRL in good condition. qty: 2 units.
76.	"	Extraction unit, type soxhlet, according to scheme RF2?3.		"	Equipment received and delivered to RDRL in good condition. qty: one unit.
77.	"	Filtration unit, type 423, according to scheme 122.		"	" "
78.	"	Filtration group, according to scheme 3CH 129.		"	" "
79.	"	Primary evaporation unit.		"	" "
80.	"	Versatile extraction plant type T425.		"	" "
81.	"	Unit for extraction of pine tree resin.		"	" "
		Total amount for 9 items:-	390,000		The total amount includes $ 20,000 freight charges.

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(1)	(2)	(3)	(4)	
32.	15-3-00265	Vacuum Pump body M/S. Tournaire. B.P. 4 Plan de Grasse 06333 Grasse France. Attn: Mr. J.M. Chiocci.		Equipment expected in Mid May'88 qty: one unit.
33.	"	Georgin Regulation Valve for Vacuum Pump.		" "
34.	"	Klein Valves PN 10 (4 1/2" - 2 3/4"- 2 1")		qty: 3 nos.
35.	"	Sarco 3P 422 Steam Traps.		qty: 4 nos.
36.	"	Threaded Valves (2X3/4" - 4X1/2")		qty: 6 nos.
		Total amount for 5 items:-	3,513	

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Equipment for Process Control Laboratory under process of procurement

Sl. No.	Description	Approx. amount in US$	Remarks
1.	GLC/accessories/installation	20,000	Request for the purchase of equipment/apparatus has already been sent to UNIDO, Vienna.
2.	TLC with accessories	1,000	
3.	Refractometer	200	
4.	Balance (2)	1,500	
5.	Chromatography column	100	
6.	Glass Soxhlets	500	
7.	Heating mantles (6)	1,500	
8.	Gas Cylinders (300) and gauges - (6)	1,000	
9.	Air Compressor	500	
10.	Chemicals, Glassware, Solvents and related Consumables	5,000	
11.	Hydrogen Generator	5,000	
12.	125Kw Stand by Electricity Generator (Indian manufacture)	15,000	
	Total U.S.$:-	51,000	

Equipment/spare parts of FT-IR for RDRL under process of procurement

Sl. No.	E.P.S. No.	Description	Amount in US$	Remarks
13	001580	FT-IR major spareparts with accessories	9,173	Order placed on 9 May 1988 to M/S. Nicolet Analytical Division Madison, WI-53711, USA, Confirmation from the supplier is awaiting.

Staff Trained

Annex 2

Training already fulfilled

S.No.	Candidate	Field	Duration	Institute
1.	Mr. D.D. Bhattarai	Drug Analysis	6 months	Central Drug Lab., Calcutta.
2.	Mrs. Muna Rajbanshi	,, ,,	12 months	Govt. Analytical Lab., Bombay.
3.	Mr. P.M. Shakya	Microbiological Assay	6 months	Hindustan Antibiotics, Poona.
4.	Mr. M.P. Amatya	Bioassay	6 months	Haffkine Institute, Bombay.
5.	Mr. C.P. Neupane	Drug Analysis	6 months	Central Drug Lab., Calcutta.
6.	Mr. L.K. Vaidya	Drug Analysis	6 months	,,
7.	Mrs. Kamala Rijal	Microbiological	12 months	IDPL, Rishikesh Centra Drug Lab. Calcutta.
8.	Mr. S.K.G . Joshi	Bioassay	6 months	National Control Lab. for biologicals, Bangkok.
9.	Mrs. Hari Devi Shrestha	Instrumental Methods of Analysis	4 months	National University of Singapore.
10.	Mr. N.P. Shrestha	Training in unit operation in the extraction of medicinal plants	6 months	U.K., France, F.R.G., India.
11.	Mrs. Padma Prajapati	Training in Phytochemistry	6 months	University of Sydney.
12.	Mrs. Sumitra Vaidya	,,	3 months	,, ,,
13.	Dr. L.R. Sharma	Training in Economic mapping	6 months	Italy.

S.No.	Candidate	Field	Duration	Institute
14.	Mr. B.B. Basukala	Farm Management	3 months	India
15.	Mr. D.P. Shrestha	Maintenance of Pilot Plant Equipment	6 months	India
16.	Mr. B. Das	Training in Synthetic Chemistry	6 months	U.K.
17.	Mrs. Madhavi Shrestha (Deceased)	Practical Training on analysis of Pharmaceuticals & Crude drugs	4 months	F.R.G.
18.	Mr. A.K. Pandey	Training in Glass Blowing for repair & fabrication of lab. glass apparatus	6 months	India
19.	Mrs. Ranila Joshi	Training in Synthetic Chemistry	15 months	U.K.

Study Tours/Seminars already completed

S.No.	Candidate	Field	Duration	Institute
1.	Dr. S.R. Adhikary	Asian Chemical Conference of workshop on micro-computers in lab. automation	6 days	Singapore.
2.	Mr. A.D. Shrestha	Pilot Plant Equipment Management	1 month	Italy, France, Austria, F.R.G., India.

S.No.	Candidate	Field	Duration	Institute
3.	Dr. S.B. Rajbhandary	Manufacture of drugs based on medicinal plants & essential oils processing	6 weeks	Bulgeria, Hungary, China.
4.	Dr. P.M Adhikary	Quality Control aspects of drugs	3 weeks	Netherlands, F.R.G., Japan.
5.	Dr. S.R. Adhikary	Quality Control aspects of drugs	1½ month	Norway, U.K., F.R.G.

Study Tour to be completed

1.	Dr. S.B. Malla	Research Development aspects of Medicinal Plants based drugs	1 month	Australia, S. Korea, Thailand.

Under Trainign

S.NO.	Candidate	Field	Duration	Institute
1.	Mr. Y.N Sukla	Terpenoid Chemistry	6 months	Maltichem, Baroda, India.

Under Process for Training

S.No.	Candidate	Field	Duration	Institute
1.	Mr. A.K. Agrawal	Toxicology/ Pharmacology	3 months	India.
2.	Mr. A.N. Poudel	Pharmacological Screening	3 months	India.
3.	Mr. N.R. Joshi	Drug Formulation	3 months	China.
4.	Dr. K.R. Amatya	Pine rosin Chemistry	4 weeks	India, Australia.
5.	Dr. Timila Shrestha	Ergot alkaloids	4 weeks	Hungary.
6.	Dr. A. Rajbhandari	Centella Asiaticoside glycosides	4 weeks	France.
7.	Mrs. Bimala Pradhan	Technical Planning and Evaluation	4 weeks	India.
8.	Mr. R.R. Prasad	Process Technology	3 months	Japan.

Annex - 3 .

Agency Personnel (Experts) (Status as at 31/5/88)

Sl. No.	Name of Incumbant	Post Description	Arrival	Departure
1.	Mr. John G. Meredith (U.K.)	CTA/Production Technologist.	Aug 1982	Feb 1984
2.	Dr. J.P. Williams (U.K.)	Pharmacologist.	Dec 1982	Nov 1983
3.	Dr. Jan Karlsen (Norway)	Analytical Chemist.	Jan 1983	Jan 1984
4.	Mrs. M.M. Cordes (Holland)	Microbiologist.	Jan 1983	Jul 1983
5.	Mr. W.J. deBoeck (Belgium)	Economist/Associate Expert.	Mar 1982	Feb 1983
6.	Mr. F. Sandberg (Sweden)	Consultant in Pharmacology.	Apr 1982	May 1982
	"	"	Sep 1982	Oct 1982
7.	Dr. O. Bojer (Rumania)	Expert in Economic Mapping.	Mar 1984	Jul 1985
8.	Dr. R.C. Srimal (India)	Pharmacologist.	Mar 1987	May 1987
9.	Mr. S.K. Suri (India)	Expert in Instrument Maintenance	Jan 1988	May 1988
10.	Mr. M.B. Narashimha (India)	Process Technologist.	Jan 1988	Jun 1988
11.	Mr. W.D. Henry (Sri Lanka)	Expert in Glass Blowing.	Jun 1988	Jul 1988

Annex - 4.

The Status and Prospect of RDRL Pilot Plant Laboratory at Godavary

M.B. NARASIMHA
UNDP/UNIDO Expert in Process Technology

Introduction

Status

UNDP/UNIDO has created an excellent infrastructure base for conducting basic and applied researvh at RDRL, Thapathali and Godavary vide Project: DP/NEP/80/003, entitled "Strengthening the Royal Drug Research Laboratory", a constituent of the Department of Medicinal Plants, HMG of Nepal, with a view to exploit the rich and varied flora, indigenous to Nepal.

A pilot plant section has been created at Godavary, with the following equipment to enable it to successfully develop, demonstrate and transfer, technologies in the industrial utilization of medicinal and aromatic plants:

1. Versatile Extraction Unit: Capacity 250 Litrs
2. Sohxlet Extractor: Capacity 500 L
3. Percolator: Capacity 300 L
4. Three-Stage Mixer-Settler type Liquid-Liquid Extractor
5. Vacuum Concentrators/Distillation Stills

   a. Capacity: 500 L Without Stirrer
   b. Capacity: 300 L With Stirrer
   c. Capacity: 100 L With Stirrer

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6. Reactor (Hastealloy) Capacity: 250 L
7. Distillation Still With Stirrer: Capacity 1000 L.
8. Pressure Leaf Filter
9. Rotary Vacuum Filter
10. Spray Drier
11. Hammer Mill
12. Jaw Crusher
13. Steam Boiler: Capacities 1500 kg/hr from and at 100°C, Oil fired-automatic

All the items, except, item nos. 10 to 13 have been supplied M/S. Tournaire, France.

In addition to these units, the following equipments installed at the premises of RDRL at Thapathali prior to the commencement of the Project are also available:

1. Stainless steel essential oil distillation unit: Capacity:2000 L
2. Glass-lined reactor with stirrer: Capacity: 100 L
3. Stainless steel reactor with stirrer: Capacity: 250 L
4. Electrically heated distillation unit: Capacity: 200 L
5. Stainless steel basket centrifuge
6. Shelf drier: 24 aluminium trays
7. Disintegrater
8. Steam boiler-oil fired, automatic capacity 300 kg/hr from and at 100°C.

With these combined facilities and the infrastructure base built within the scope of the project at RDRL, R & D work for the development of process technologies for the production of natural products is in full swing.

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Shortcomings

However, some shortcomings as enumerated below, have been noticed in some of the units at Godavary:

1. Versatile Extraction Unit:

No arrangements exists for refluxing, part of the condensate into the packed column, which is very necessary for the rectification of dilute recovered ethanol, thus, restricting the use of this unit for extractions with water immiscible solvents only.

2. Percolator has not been provided with a system for the recovery of residual solvent from the marc, thus limiting its use with aqueous solvents only.

3. Three - stage mixer settler type liquid - liquid extractor is incomplete and inoperable in absence of pumping arrangements, to pump miscella and raffinate streames to the distillation stills for the recovery of solvents and extracts.

Suitable action has been initiated to effect modifications to these units, as also minor modifications of the following units to make their use more flexible and broad based.

1. Two vacuum concentrators of 300 L and 100 L Capacities fitted with stirrers, are planned to be converted to act as reactors in addition to their use as vacuum concentrators with minor modifications.

2. Soxhlet Extractor:

This unit takes about 10 - 15 hours per batch. To cut down the batch time and also with a view to extend its function as a percolator the pipeline conections are planned to be modified, to facilitate circulation of miscella, using the existing solvent pump.

Additional Equipment Suggested

1. Fractional distillation unit of the capacity of about 100 L per batch, equipped with high efficiency internal packings, reflux distributor with electronic timer, vacuum pumps, interconnecting pipes and fittings and M.S. structures. Expert in process technology can help in its design and getting it fabricated locally.

2. Multistage centrifugal type liquid - liquid extractor, with provision for separation clarification bowls with accessories.

Design & Engineering

It is suggested that, while developing technologies for the industrial utilization of indigenous medicinal and aromatic plants, simultaneous development of design and engineering expertise and suitable infrastructure for fabrication of chemical plant and equipment, would not only quicken the process of transfer of technologies from pilot plant level to the user industry, but saves valuable time and foreign exchange and hence a compulsive need of a developing country like Nepal.

These activities may be developed, in a phased manner. In the first phase the expertise development may cover basic design of plant and equipment and have the plants fabricated in the engineering workshops in Kathmandu. At a later stage if found necessary, fabricational facilities may be built.

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Staff

The present staff of Pilot plant consists of four qualified Pharmacists, a physical chemist and two technicians. Considering the nature of developmental work, and suggested augmentation of design and engineering facilities, it is an absolute necessity to have at least a couple of graduate chemical Engineers on its rolls.

Process - Control at Godavary

The process development and scale up operations are being conducted at Godavary and the samples are being sent to Thapathali for analysis, very essential for process - control, this arrangement is impractical and leading to avoidable delay in the development of technologies. The proposed - Control laboratory, for which I understand the funds were approved in the TPR held in 1986 and the equipment ordered subsequently, should be established at the earliest; without this laboratory it would be difficult to operate the pilot plant efficiently.

Prospects

With the suggested modifications to the existing pilot plants, shifting of all the pilot plants from RDRL premises at Thapathali to Godavary, addition of the afore-mentioned equipment and augmentation of technical staff, the pilot plant facilities at Godavary would form the best possible technical base, to generate and transfer technologies not only in the commercial utilisation of a broad spectrum of aromatic and medicinal plants of Nepal, but also in the process development of synthetic drugs and pharmaceuticals.

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General Remarks

Applied research as compared to basic research is capital intensive, hence prior to undertaking pilot plant studies, the results obtained at bench-scale, should be subjected to indepth evaluation, for technical feasibility by competent scientists and technologist, upon their recommendations for technical feasibility and national priorities, pilot plant studies are to be undertaken for in-depth studies to establish not only technical feasibility but also economic viability of a new process know-how, and to obtain sufficient data for scaleingup to industrial operations.

Suitable methodology, has to be developed for periodic review, course correction, when necessary, proper checks and controls during the stage of development.

A pilot plant section like the one at Godavary with built-in infrastructure to undertake applied research, is expected to successfully develop, demonstrate and transfer technologies and act as a nerve centre:

- to generate technically feasible and economically viable technologies in the utilisation of natural products.
- to provide R & D facilities to the industry.
- to provide consultancy and advisory services.
- for training and development of technical manpower.

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For the above services, a lumpsum premium/charges should be collected from the user industry.

After establishing, credibility of the capacity to develop know-how and competence of its scientific and technical personnel in successfully transfering the know-how in establishing small and medium scale industries, industrial enterpreneurs would come forward to sponsor programmes to generate know-how/technologies.

Annex - 5 .

Joint Coordination Committees Meetings held:
July 1986 - May 1988.

1. Royal Drugs Ltd. & Royal Drugs Research Lab.
July 15, 1986; Sept. 28, 1986; March 30, 1987;
April 22, 1988.

2. Herbs Processing and Production Company Ltd. &
Royal Drugs Research Lab. July 16, 1986;
Nov 18, 1986; Jan. 18, 1987; April 5, 1987;
Sept. 8, 1987; Dec. 4, 1987.

3. Singh Durbar Vaidya Khanna & Royal Drug Research
Lab. Dec. 23, 1986; March 2, 1987; May 3, 1987;
Jan. 21, 1988.

RD Ltd. & RDRL held on 15 July 1986

The Meeting was attended by:

a. Dr. M.D. Tuladhar - Co-ordinator

b. Dr. S.B. Malla

c. Dr. S.B. Rajbhandari

d. Dr. P.M. Adhikari

e. Mr. A.D. Shrestha

f. Dr. S.R. Joshi

g. Dr. Nitya Anand - UNIDO Consultant

Discussions were held on the agenda prepared by RD Ltd. and the following points were decided to undertake:

1. RDRL will provide 100 samples of Antirheumatic ointment for test marketing after completing the fests for stability, physical characteristics, dispersibility etc.

ii. It was decided to formulate Rauwolfia tablets in total alkaloids in terms of 0.1 mg . of peserpine.

iii. To decide about the formulation of Triphala tablets in the next meeting after studying its consumption.

iv. To undertake formulation of Centella asiatica in the form of cream or powder and study its feasibility.

v. It was decided to formulate different products based on the proposed Essential Drug List of the WHO.

vi. RDRL will provide samples of eight different formulated products to RD Ltd. for market study.

Minutes of the Co-ordination Committee meetings

HPPCL and RDRL held on 16 July 1986

The meeting was attended by:

a. Dr. S.B. Malla
b. Dr. S.B. Rajbhandari
c. Dr. P.M. Adhikari
d. Dr. S.R. Adhikari
e. Mr. A.D. Shrestha
f. Dr. B.C. Gulati
g. Dr. A. Sheak

Discussions were held on the agenda prepared by HPPCL and following points were decided to undertake:

a. Authentic specimen of Sugandha Kokila will be collected for identification purpose.
b. Artemesia - It was requested by HPPCL to provide information regarding the number of sps. found in Nepal. They also requested for a herbarium specimen after proper identification. HPPCL will provide information regarding the Artemasia sps. which have international demand.
c. RDRL will evaluate the oil from Juniper berry obtained from HPPCL.
d. Economic survey and mapping will be conducted by Dept. of

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Medicinal Plants on Cinnamomum , Xanthoxylum and abbies sps.

e. Cultivation practice of Cinnamomum, Osmanthus and Tagetes minotar will be studied by the Dept. of Medicinal Plants.
f. It was requested by HPPCL for handing over of the technology for extraction of l-dopa from Mucona sp.
g. It was also discussed to work out a suitable mechanism for handing over of the developed technologies from RDRL to HPPCL.

RDRL and RD Ltd. held on 28 September 1986

The meeting was attanded by:

1. Dr. M.D. Tuladhar - Co-ordinator
2. Dr. S.B. Malla
3. Dr. P.M. Adhikari
4. Mr. A.D. Shrestha
5. Dr. S.R. Joshi.

Discussions were held on the agenda prepared by RD Ltd. and the following points were decided to undertake:

i. The Triphala tablets after formulation was found to be very hygroscopic so it was decided to discontinue formulation of this product.

ii. It was decided to form a Technical Formulation Committee consisting of the following members:

1. Mr. N.R. Joshi
2. Mr. B.B. Thapa
3. Mr. T.R. Shakya
4. Mr. R.B. Tuladhar
5. Dr. S.R. Joshi
6. Mr. A.D. Shrestha - Co-ordinator

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This committee will be mainly responsible for selection of new formulations and recommend this to the Medical Committee of the RD Ltd.

iii. It was decided to name the Balm preparation as Rhino Balm and provide details to RD Ltd. for formulation purpose.

HPPCL and RDRL held on 18 November 1986

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. S.B. Rajbhandari
3. Dr. B.C. Gulati
4. Dr. P.M. Adhikari
5. Dr. S.R. Adhikari
6. Mr. U.R. Poudel
7. Dr. A. Sheak.

Discussions were held on the agenda prepared by HPPCL and the following points were decided to undertake:

i. It was decided that introduction of new plant samples in cultivation will be taken by both HPPCL and RDRL while HPPCL will lay emphasis on market assessment of the oil or extracts; DMP & RDRL on the other hand will perform agro technological experiments, post harvest treatments and quality assessment of the products.

ii. The items like Basil, Tagetus, Mentha piperate, Mentha citrata, Mentha spicata, Citronella were decided to be extended for introduction and cultivation to the farmers.

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iii. It was decided to continue R & D work by RDRL on Juniper leaf oil, Acorus calamus oil.

iv. Development work for production of superior quality of Rosin by Pilot Plant section, RDRL is sought by HPPCL on Rosin & Terpentine sample supplied by them.

v. Joint process development programme on Dioscrea and fat from Sugandha Kokila was discussed. Need for further collaborative work on them was emphasised.

vi. A joint programme for extraction of tree moss was decided to be discussed in detail by the respective task force group.

SDVK & RDRL held on 23 December 1986

The meeting was attended by:

1. Dr. R.P. Mishra
2. Dr. S.B. Malla
3. Dr. S.B. Rajbhandari
4. Dr. S.R. Adhikary
5. Dr. R.B. Sahu
6. Mr. U. Thakur - Co-ordinator

Discussions were held on the agenda prepared by SDVK and the following points were decided to undertake:

i. Quality control of Mrit-Sanjibani Sura by RDRL by estimating alcohol content.

ii. SDVK will provide details about availability demands etc. to RDRL for preparation of a Project for processing of Shilajeet.

iii. SDVK will provide technical know-how to RDRL regarding formulation Chyawonpras.

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HPPCL & RDRL held on 18 January 1987

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. P.M. Adhikary
3. Dr. B.C. Gulati
4. Dr. A. Sheak.

Discussions were held on the agenda prepared by HPPCL and the following points were decided to be undertaken:

i. Artemesis sps. - Dept. of Medicinal Plants will conduct techno-economic survey of the available sps. of this plant for commercial utilization.

ii. RDRL will perform chemical assessment and characterization of oils from Juniper leaf, Rhododendron citosum, Abies leaf oil.

iii. Pilot Plant Section, RDRL will handover the technology on the production of improved quality of Rosin & Turpentine for production trial at the HPPCL Tamagadhi unit.

iv. Belladonna extract and total alkaloids:- This preparation prepared by RDRL was found to detioriate on storage. It was therefore suggested by HPPCL to study the factor responsible for this so that method for production of the stable extract is evolved.

v. R & D work on the needs containing high percentage of fixed oil/fats was suggested to be undertaken by Dept. of Medicinal Plants for economic production.

vi. A suitable solvent system was suggested to be developed by RDRL for extraction of Tree moss with good quality product.

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SDVK & RDRL held on 2 March 1987

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. R.P. Mishra
3. Dr. S.B. Rajbhandari
4. Dr. P.M. Adhikary
5. Dr. S.R. Adhikary
6. Dr. R.B. Sahu
7. Mr. U. Thakur - Co-ordinator

Discussions were held on the agenda prepared by HPPCL and the following points were decided to undertaken:

i. It was decided to formulate a project proposal on Shilajeet keeping in view of the present production scale of the SDVK, market demand at present and projected demand till 2000 A.D.

ii. SDVK will provide samples of Mirta - Sanjibani Sura and the plants materials used in preparation of Chaywonprash to RDRL for quality control and standardization purpose.

RD Ltd. and RDRL held on 22/4/1988

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. M.D. Tuladhar - Co-ordinator
3. Dr. P.M. Adhikary
4. Mr. A.D. Shrestha
5. Dr. S.R. Joshi

Discussions were held on the agenda prepared by RD Ltd. and

the following points were decided to undertake:

a. Shital Liquid Balm - In order to prepare this preparation RD Ltd required about 10 litres of Eucalyptus oil and 25 litres of wintergreen oil. It was suggested that the required quality may be distilled from the available leaves and supplied to them by RDRL. But, in view of the commercial scale production of this product it was decided to procure the required quality of the oil from HPPCL.

b. Capsicum ointment - RD Ltd. wanted quality control results and procedure for this product for which RDRL is at present working at.

c. As requested by RD Ltd. RDRL will provide samples of Pine oil disinfectant for trial purpose.

d. RDRL will also provide Rauwolfia extract tablets after standardization in terms of reserpine content.

e. It was decided to undertake market feasibility of Turpentine liniment by RD Ltd. so that few trial samples could be formulated by RDRL.

RD ltd. & RDRL held on 30/3/1967

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. M.D. Tuladhar - Co-ordinator
3. Dr. P.M. Adhikary
4. Mr. A.D. Shrestha
5. Dr. S.R. Joshi

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Discussions were held on 5 types of formulations which are under development in the RDRL. They are:

a. Shital Liquid Balm - It was decided to lower the percentage of lavender in the formulation. For quality control purpose estimation of total oil conduct alone was suggested.

b. Antirheumatic ointment - It was decided to perform quality control of this product according to BPC 1973. Estimation of Capsicin and total oil content to be done.

c. Formulation of Balm
It was decided to undertake quality control of this product. It was also decided to name Yeti Balm.

d. Pine oil disinfectant - It was decided to compare the potency of the product with Phenyle disinfectant.

e. Centella asiatica ointment - It was decided to try HPLC method for estimation of Ilycosides.

RD Ltd. staff expressed their interest in those formulation and it was decided that they would carry out a market feasibility survey and then revert back to the JCC (Joint Co-ordination Committee).

HPPCL & RDRL held on 5 April 1987

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. B.C. Gulati
3. Dr. P.M. Adhikary
4. Dr. S.R. Adhikary
5. Mr. A.D. Shrestha
6. Mr. U.R. Paudel
7. Dr. A. Sheak - Co - ordinator.

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i. Artemesia sps. - An economic survey on the available sps. of Artemesia will be carried out by the Dept. of Medicinal Plants. The herbarium specimens will be provided to HPPCL for reference purpose in collection.

ii. The oil samples of Juniper recurva, Abies spectabilis and Rhododendron anthropogan will be sent to RDRL for proper characterization and identification of the constituents. Similarly, oil of E. Cameldulensis will be sent by the Dept. of Medicinal Plants for market investigation.

iii. The Belladonna extract containing 3 % alkaloid was not found stable on storage so it was suggested by HPPCL to either to dry the extract to powder state or add proper solvent or preservative for storage.

iv. It was requested by HPPCL to provide agro-technology of Dill and Salvia for cultivation purpose.

v. The fixed oil of Sugandha Kokila is likely to have many pharmaceutical applications. It was therefore suggested by HPPCL for assessing the dermal toxicity of the oil.

vi. Improved method of extraction of Lichen was sought by HPPCL using proper solvent.

vii. The distillation method on Acorus calamus oil provided by RDRL to HPPCL was found interesting to them as this would economise the production technology of the oil.

SDVK & RDRL held on 3/5/ 1987

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. R.P. Mishra
3. Dr. S.B. Rajbhandari
4. Dr. P.M. Adhikary
5. Dr. S.R. Adhikary
6. Dr. R.B. Sahu
7. Mr. [illegible] Thakur - Co-ordinator

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a. It was decided to solve the problem of filtration of Shilajeet at the Pilot scale by utilizing the modern machineries.

b. or quality control purpose it was suggested to develop the method utilizing the authentic Shilajeet.

HPPCL & RDRL held on 8 September 1987

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. B.C. Gulati
3. Dr. S.B. Rajbhandary
4. Dr. P.M. Adhikary
5. Dr. S.R. Adhikary
6. Mr. A.D. Shrestha
7. Mr. U.R. Paudel

a. Artemisia sps. - It was proposed to collect new sps. from Mustang & Dolpa for evaluation of the oil.

b. Juniper berries - Collection of the ripe berries is desirable. As the collection of berries is time consuming it will be better to purchase them from the local market. The oil will be sent by HPPCL to RDRL for evaluation.

c. Xanthoxylum sps. - RDRL will select the high oil containing plant from Dang, Rolpa districts and the cuttings of such plants will be planted for propogation. HPPCL will help in bearing the cost of this operation.

d. It was reported by HPPCL that the alkaloid content of Belladonna soft extract dropped to nearly 50 % within three months of storage. It was therefore suggested to RDRL to look into this problem of deteriotion.

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e. It was suggested to RDRL to extract lichen resioids in toluene. Extract having greenish colour was preferable.

HPPCL & RDRL held on 4 December 1987

The meeting was attended by:

1. Dr. S.B. Malla
2. Dr. S.B. Rajbhandary
3. Dr. B.C. Gulati
4. Dr. P.M. Adhikary
5. Dr. S.R. Adhikary
6. Mr. A.D. Shrestha
7. Mr. U.R. Paudel
8. Dr. A. Sheak - Co-ordinator

a. Follow up of the problem in identification of Artemesia sps.

b. It was suggested by HPPCL for containing co-ordination with RDRL for work on Acorus Calamus oil.

c. Transfer of technology from RDRL for processing of herbs of export potential like Dioscorea, Essential oil bearing plants etc.

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RDRL & SDVK held on 21 Janurary 1988

The meeting was attended by;

1. Dr. S.B. Malla
2. Dr. R.P. Mishra
3. Dr. S.B. Rajbhandari
4. Dr. P.M. Adhikary
5. Dr. S.R. Adhikary
6. Dr. R.B. Sahu
7. Mr. U. Thakur - CO-ordinator

a. As there are about 300 medicinal plants in the proposed Essential Drug list of Ayurveda, it was proposed by SDVK for a long term co-ordination programme with the RDRL in quality control and standarisation of the plant constituents.

b. It was also proposed by SDVK for a technology on large scale processing of Shilajeet.

Annex - 6 (a)

Formulations developed

Deep Heat Cream

Background

Turpentine oil, eucalyptus oil and oil of Wintergreen have been in traditional use for rheumatic disorders. As these oils can be produced in large quantity in Nepal, it was decided to formulate a preparation containing these oils for muscular pain rheumatic disorders. This product has also been identified by Royal Drugs Ltd for marketing.

Uses: For muscular and rheumatic disorders.

Standard: Total Volatile oil content and Methyl salicylate content.

Formula: Each 100 gm contains

Stearic acid	- 9.5 gm
Cetyl alcohol	-11.8 gm
Glycerine	- 9.2 gm
Sodium Lauryl Sulphate	- 1.2 gm
Propyl paraben	- 0.004 gm
Methyl salicylate	-13.5 ml
Eucalyptus oil	-2.0 ml
Turpentine oil	-1.5 ml
Water (distilled)	-46.00 ml
	100

Procedure:

Melt stearic acid, cetyl alcohol and dissolve propyl paraben in it. Mix glycerine, sod. Lauryl sulphate and water and warm to 75°c. Add glycerine mixture stearic acid mixture stirring continuously. Add oil mixture i.e. menthol dissolved in Eucalyptus oil, Turpenti: oil and methyl salicylate stirring continuously until it attends 40°c.

Cost:

The raw material cost for 25 gm would be Rs 4.20

Conclusion;

Similar preparations are not available in the Nepal market, although similar preparations are popular in western countries. Royal Drugs Ltd. is intending to manufacture and market this formulation.

Pine oil disinfectant

Technological work for development of a process for production of pine oil is in progress in RDRL due to abundent availability of various species of pine trees in Nepal. Pine oil is mostly used as a disinfectant, so preparation of a disinfectant formulation based on pine oil was undertaken.

Uses:

Pine oil disinfectant is used as deodorant and disinfectant for cleaning sinks, drains, carpet, rugs, wood panels, garbage bins & floors etc. Pine oil emulsions are non-toxic, non-irritating and safe.

Standardisation:

(i) Total Pine oil content (Terpineol)

(ii) Phenol Coefficient Value

Procedure:

Pine oil - 80 ml
Rosin Soap - 20 gm.

Procedure:

Dissolve the rosin soap in pine oil and filter.

Standard of Pine oil

The specification of pine oil needed for this preparation is as follows:

	% w
Dihydro -alpha -terpineol	65-70%
and other tertiary alcohols	10
Borneol and fenchyl alcohol	10 - 15
Estrageole	5
Ketones	5 - 10

It distilles between 212 and 220c and has sp. gr. 0.83-0.94.

Problem:

Pine oil containing only 28 % of -Terpineol has been made available.

Rosin Soap:

For pilot scale production, a series of soap making machines would be needed.

Cost:

The raw material cost for 100 ml of product would be Rs. 7.60.

Conclusion:

Due to the pleasent flavour and effectiveness, this household disinfectant should have good market, if advertised, hence should be

considered for manufacturing. The product could also be modified by adding chloroxylenol which enables it to be used for routine hospital purposes. Particularly in midwifery and surgery.

Turpentine Liniment

Background

The abundent availability of turpentine oil, (processed by Nepal Rosin and Turpentine Ltd., Dhangadhi) and the high consumption of preparation used for rheumatic pains and stiffness demand of its production. Furthermore, this is one of the products included in the list of medicines supplied by the Dept. of Health to all the Hospitals, health centres and health posts.

Uses

Externally, turpentine oil is a rubefacient used for rheumatic pains and stiffness.

Standard

This product is included in I.P. and B.P. 1980.

Preparation

Turpentine liniment - B.P. 1980 Vol II 683.

Soft Soap	- 7.5 gm
Camphor	- 5.0 gm
Turpentine oil	- 65.0 ml
Purified water	- 22.5 ml

Procedure

Triturate the camphor with the soft soap until thoroughly mixed and gradually add the turpentine oil trituating well after each addition. Transfer the mix to bottle with the aid of the purified water and shake thoroughly until a creamy emulsion is formed.

Cost

The raw material cost for 100 ml material would be Rs. 2. 85.

Conclusion

Due to the availability of the raw material and its economic price the product seems to be worth manufacturing.

Anticold and antirheumatic oil

Background

Traditionally mentha oil, eucalyptus oil, Wintergreen oil and camphor have been used since long time for the problems of cold,headache, lumbago sciatica etc. All of these essential oils are available in Nepal. Similar preparations are imported in huge quantities so this preparation has been undertaken for formulation.

Uses

It is useful for rheumatism, Neuralgia, lumbago sciatica, colds, headache, toothache, seasickness, vomitting and diarrhoea etc.

Standardisation

Total volatile oil content

Formula: Each 100 ml Anticold and antirheumatic oil contains:

Menthol	- 40% w-v
Methyl Salicylate	- 10% w-v
Eucalyptus oil	- 15% w-v
Camphor	- 10% w-v
Light liquid paraffin	- 9.5 to 100 ml.

Procedure

Dissolve menthol and camphor in methyl salicylate and Eucalyptus oil. Add liquid paraffin to make up the volume.

Cost

The raw material cost for 5 ml material would be Rs. 1.30

Conclusion

Due to its wide application and economic price the product is to be manufactured. Royal Drugs Ltd. has already decided to manufacture it.

Anticold and antirheumatic Balm

Background

Preparations in the form of balm containing menthol, camphor, peppermint oil and eucalyptus oil, which are produced in Nepal itself have been imported in large quantities from foreign market. With a view of import substitution and indegenous raw material utilization this product has been considered for formulation.

Uses

It is an excellent pain reliever (anodyne) anti-itching remedy for the relief of colds, influnza, rheumatism, gout, neuralgia, headache, toothache, mosquitobite and insect bites etc.

Standardisation

Total volatile oil content.

Formula

Menthol	- 14% w/w
Camphor	- 14% w/w
Peppermint oil	- 8% w/w
Eucalyptus oil	- 10% w/w
Clove oil	-2.5% w/w
Cinnamon oil	-2.5% w/w
Beeswax	- 14% w/w
Carnauba wax	- 9% w/w
Vaseline Yellow	- 26% w/w

Procedure

Melt. Bees wax, carnauba wax and veseline.

Mix essential oil, menthol and camphor uniformly and add it to the melted wax and mix at 50° c.

Cost

The raw material cost for 20 g material would be Rs 4.80.

Conclusion

Royal Drugs Ltd. has accepted to include this product in their range of production in near future.

Reserpine Tablets

Background

Reserpine is an alkaloid obtained from the roots of Rauwolfia serpentina. The plant is being cultivated in commercial scale. Rauwolfia sepentina as well as reserpine is included in several pharmacopoeias. Various preparations like powdered root (USP), tablets of powdered roots (USP) (BPC) dry extract (IP) liquid extract (IP) Reserpine elixier (USP) Reserpine injection (USP) Reserpine tablets (USP) (UK) are available. The preparation are used as a central depressant, sedative and as an antihypertensive agent. So in order to utilize the rauwolfia roots the formulation of tablets containing reserpine or reserpine like alkaloids has been undertaken.

Uses

Rauwolfia alkaloid tablet has central depressent and sedative actions and a primary peripheral antihypertensive effect accompanied by bradycardia. It is also useful as a sedative in anxiety status and chronic psychosis.

Standardisation

Formula: Each tablet contains:

Rauwolfia total alkaloids	- 2 mg
Lactose	- 185 mg
Starch	- 14 mg
10% Acacia solution	- 1.6 mg
Dry starch 5%	- 9 mg
Magnesium stearate	- 0.9 mg
Talc 2%	- 3.6 mg

Procedure: Wet granulation process

Mix lactose, starch, and Rauwolfia extract uniformly, granulate with 10% Acacia solution by passing moistened mass through 10 No sieve, dry at 60°c and pass the dried granules through 20 No Sieve. Lubricate with dry starch, magnesium stearate and talc and compress using 5/16 inches die.

Cost:

The raw material cost for 100 tablets would be Rs 2.57.

Conclusion

The product seems to be worth manufacturing due to the availability of material, its use as an antihypertensive and its economic price.

Capsicum Ointment

Background

Capsicum has been used in Ayurvedic system of medicine and capsicum and its oleoresin have been included in several Pharmacopoeias as a counter irritant lumbago, neuralgia and rhematism. The indegeneous pine oil, wintergreen oil, turpentine oil and mentha oil which have been used traditionally are encorporated to enhance the action. Similar type of imported products are being marketed in considerable quantity.

Uses

Useful for relief of muscular pains, strains joint pains, pains of Artheritis, lumbago and Bruises.

Standard

(i) Capsicum oleoresin content
(ii) Total Volatile oil content

There is still problem for assaying the copsicum oleoresin content.

Formula

Pine oil	- 2.8% w/w
Wintergreen oil	- 4% w/w
Turpentine oil	- 8% w/w
Oleoresin Capsicum	-1.6% w/w
Mentha oil	-1% w/w
Yellow bees wax	-10% w/w
Yellow soft paraffin	-9.5 to make 100 gm

Procedure

Melt Beeswax and soft paraffin, mix pine oil, wint green oil, turpentine oil, oleoresin capsicum, mentha oil and add it to the melted wax mixture at 30°c mix well.

Cost

The cost of raw material for 1 kg. material would be Rs. 96.80.

Conclusion

Due to its wide application, Royal Drugs Ltd. is considering for its production.

1. Centella asiatica - Wound Healing Cream

Preparations have been made but due to analytical problems, this work is discontinued for the time being.

2. Laxative tablets of Rhubarb

This product has already been manufactured by Royal Drugs Ltd.

3. Antidiarrhoeal Tablet

This tablet containing Berberine Hydrochloride, Terminaeia Chebula Belladonna has not been accepted.

4. Antacid and antiulcerous tablet

This preparation containing herbal drugs as well as pure chemicals has not been accepted.

Format for Cross Behavioural Test

Qualitative and semi-quantitative Screening and
Testanimal .... Fasted/Nonfasted .... Sex ....
Report of ....
Vehicle for sample .... Cone ... . mg/ml .... mark ... ... Color Mark.... Weight(g
Sample Dosage ... . mg/kg. Note Book No .... pp ml injected ... ... Route inj ... ... Time injection ...
Tested by ... ... Evaluated by ... ...

Parameter	Time C	5'	15'	30'	2	4	6	Parameter	Time C	5	15	30	2	4	6
		Responce post dosage								Responce post dosage					
Motor Activity								Conjunctival mucosa Blanching							
Ataxia								Hyperemia							
Loss in Righting reflex								Cyanosis							
Analgesia								General Pilierection							
Respiratory Rate								Salivation							
Depth								Pilomotor erection							
Loss Corneal Reflex								Micturation							
Loss Pinna Reflex								Diarrhoea							
Paralysis-Fore legs								Priapism							
Paralysis-Hind leg								Robicsek test							
Paralysis-Head								Circular motions							
Screengrip R.L.loss								Tail-rubbing							
F.L.loss															
Cage Startle Reaction								Abdominal griping							
Motor Activity								(WRITHING)							
Fine body tremors								Rectal temp. C.							
Fasciculations								Body weight							
Clonic convulsion								Colour skin							
Tonic convulsion								Ipsilateral flexor reflex							
Mixed type convulsion								Subjective Head tap							
Rate								PASSIVE							
Resp. Depth								Fearful							
Eye Enophthalmus								Body rigidity-aggressive							
Exophthalmus								Passive							
Piloerection								Fearful							
Pupil size Norm.								Static positions							
Pupil size (light)								Excess Curiosity							
Nystagmus								Excess Curiosity							
Lacrimation								Death and autopsy							
Bloody tears								Notes.							

Result of biological tests performed on plant extracts

S.No.	Description	Parts used	LD_{50} mg/kg	Ileum of rat	Isolated guinea pig muscle of rat	Cardiovascular activity	Antifertility activity	Microbiological activity
1.	Anagallis arvensis	whole plant	10	spasmolytic	no effect	x	-ve	-ve
2.	Imperata cylindrica	" "	1000	no effect	"	x	x	-ve
3.	Clerodendron viscosum	leaf	1000	slightly spasmolytic	"	x	x	-ve
4.	Lippia nodiflora	whole plant	1000	" "	slight contraction	x	x	-ve
5.	Jatropha curcas	bark	1000	" "	no effect	x	x	-ve
6.	Cipadessa baciferа	root bark	1000	spasmolytic	contraction	-ve	-ve	-ve
7.	Plumeria rubra	bark	300	"	slight blocking	x	60 % effect	-ve
8.	Colebrookia oppositifolia	leaf	470	"	blocking	-ve	-ve	-ve
9.	Portulaca oleraceae	whole plant	1000	"	contraction	tachycardia	x	-ve
10.	Elephantopus scaber	root	500	"	slight blocking	x	x	-ve
11.	Plumbago zeylanicum	whole plant	450	"	contraction	x	-ve	-ve
12.	Ficus bengalensis	bark	500	"	"	-vex	x	-ve
13.	Salvia plebia	whole plant	1000	"	slight blocking	x	x	-ve
14.	Acacia concinna	fruit	90	"	" "	-ve	40 % effect	-ve
15.	Calliicarpa arborea	bark	1000	no effect	" "	x	x	-ve
16.	Sphaeranthus senegalensis	flower bud	1000	spasmolytic	" "	-ve	x	-ve
17.	Boerhaavia diffusa	whole plant	700	"	blocking	-ve	-ve	-ve
18.	Euphorbia hirta	" "	1 00	"	slight locking	x	x	-ve
19.	Moringa oleifera	leaf	1000	slightly spasmolytic	contraction	-ve	x	-ve
20.	Tectona grandis	bark	> 1000	" "	no effect	x	x	-ve
21.	Tadehagi triquetrum	root	750	spasmolytic	" "	x	x	-ve
22.	Gentiana prolata	whole plant	>1000	slightly spasmolytic	" "	x	x	-ve
23.	Artocarpus lakoocha	bark	200	" "	" "	x	x	-ve
24.	Morina longifolia	root	500	spasmolytic	" "	x	x	-ve
25.	Potentialla pedunculatis	root	100	slightly spasmolytic	" "	Fall in BP forshort period	x	-ve
26.	Emmala oappa	root	1000	spasmolytic	" "	x	x	-ve
27.	Ficus bengalensis	bark	500	"	contraction	x	x	x

Anthelmintic Test (in vitro)

Plants tested for anthelmintic effect using in in vitro test

Name of plants		Result
1. Melia azadirach		slightly effective
2. Butea monosperma		not effective
3. Mallotus phillipensis		effective
4. Woodfordia fruticosa		not effective
5. Embelia ribes		not effective
6. Oroxylum indicum		not effective
7. Curcuma zedoaria	root	slightly effective
8. Cleome viscosa	whole plant	silghtly effective
9. Apium graveolons	seeds	effective
10. Mallotus phillipensis	fruit hair	effective
11. Chenopodium album	leaf	slightly effective

Effectiveness was ascertained by comparing the effect with standard drug, piperazine citrate.

ANTITAPEWORM TEST

	Name of plants	parts	ALD50 mg/kg	Dose	No of mice cleared of tapeworm/ no. mice used.	Effec %
1.	Control				0/4	0
2.	Cepadessa bacifera	whole plant	1000	1000 mg/kg single	0/4	0
3.	Anagalis arvensis	whole plant	40	40 mg/kg single dose	0/4	0
4.	Colebrookia oppositifoha	leaf	400	400 mg/kg single dose	0/4	0
5.	Plumeria rubra	bark	800	500 mg/kg single dose	0/4	0
6.	Elephantopus scaber	root	600	400 mg/kg single dose	1/4	25
7.	Portulaca olearacea	whole plant	1000	1000 mg/kg single dose	0/4	0
8.	Sphaeranthus pencgalensis	flower bud	1000	1000mg/kg single dose	1/4	25
9.	Moringa oleifera	leaf	1000	1000 mg/kg single dose	0/4	0
10.	Lippia nodiflora	whole plant	1000	1000 mg/kg single dose	0/4	0
11.	Imperata cylindrica	whole plant	1000	1000 mg/kg single dose	0/4	0

	Name of plants	parts used	ALD 50 mg/kg	No. of mice cleared tapeworm/no of mice used.	Effects %
12.	Clerodendron viscosum	leaf	1000	500 mg/kg single dose	0
13.	Cepadessa bacifere	root bark	1000	500 mg/kg single dose	0
14.	Jatropha cureas	bark	1000	500 mg/kg single dose	0
15.	Salvia plebia	whole plant	1000	500 mg/kg single dose	0
16.	Acacia concinna	fruit	50	20 mg/kg single dose	50
17.	,, ,,	,,	50	10 mg/kg Morning & evening	33
18.	Boenninghausenia albiflora	whole plant	750	500 mg/kg single dose	0
19.	Mallotus phillipensis fruit hair.			1.1 mg/kg single dose	100
20.	Thenopodium			500 mg/kg single dose	0
21.	Apiumgraveolms			1000 mg/kg single dose	0
22.	Buteamonosperna			45 mg/kg single dose	0
23.	Cleome viscora			500 mg/kg single dose	0
24.	Curcuma zedoaria			1000 mg/kg single dose	0
25.	Bauhinia variegata			1000 mg/kg single dose	0

Acute toxicity

Acute toxicity test on following species of Aconites. Names of some species are code numbered.

Name of samples	App. LD50 mg/kg
1. [illegible]	40
2. [illegible]	5
3. [illegible]	1000
4. [illegible]	1000
5. ACH_2	1000
6. Nirmasi	375
7. Aconitum heterophyllum	300
8. 39/19	1000
9. 39/14	125
10. 39/3	2
11. 39/5	125
12. HFT	750
13. Aq	250

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PHYTOCHEMICAL SCREENING OF PLANTS

No.	Plants	Parts	Alka-loid	Terpen-oid	Sterol	Vol. oil	Carde-noice	Flavo-noid	Couma-rin	Tan-nin	Redu-cing comp'd	Antho-cyani-dine	Poly-eno-noid	Sapo-nin	Poly-ose	Fatty acid	Yield of extract
1.	Anagallis arvensis	whole plants		+++		+				++	++		++	++		+	19.1 %
2.	Imperata cylindrica	"			+++					Trace	++			++			7.9 %
3.	Clerodendron viscosum	leaf			+++	Trace				++	++		+	+		trace	23.34 %
4.	Tiliopsis nodiflora	whole plants			++-	+		+		Trace	++		+	++			15.30 %
5.	Jatropha curcas	Bark			++					+	+		+	+		+	13.32 %
6.	Clpadessa baciferа	Root bark		-		Trace				+	++		+	++		+	13.30 %
7.	Plumeria rucra	Bark		+							+++			+		++	17.92 %
8.	Colacrookia oppositifolia	leaf		-		+				+	+		+	+		-	14.2 %
9.	Elephantopus scaber	Root			+					+---	---		+---	+--		+--	11.5 %
10.	Portulaca oleracea	whole plant		--									+---	+--		trace	24.0 %
11.	Plumbago zeylanicum	"	+--		+	+				trace			+	+---	+		10.30 %
12.	Ficus senegalensis	Bark			+					+--	+					+	15.56 %
13.	Salvia plebia	whole plants			+	+--		+---			+					+--	7.4 %
14.	Acacia concinna	Fruit	++								-			+---		+	20.56 %
15.	Calliearpa arborea	Bark				--				+--	+--		--	+--			13.0 %
16.	Sonaeranthus senegalensis	Flowers		+		-				+			+	+		+--	15.6 %
17.	Scennia hausenia albiflora	whole plant		-		+-		+--		--	+			-	+		13.38 %
18.	Euphorbia nivia	whole plant			+	-				--	+--				+	-	15.1 %
19.	Moringa oleifera	leaves	+--							--	+--				+		21.9 %
20.	Tectona grandis	Bark				+				++	+--				+	++	21.16 %
21.	Morina longifolia	Root								-	+	--				++	18.6 %
22.	Artocarpus lakoocha	Bark			++	-					Trace						16.9 %
23.	Tadenagi triquetrum	Root			+--						++					+-	20.3 %
24.	Bistentilla pedunculoris	Root			+	-				++	+++		-				27.4 %
25.	Tinnula capna	Root								+	+-+				+	+	13.3 %
26.	Annona squamos	Leaves	++							-	+--				+	---	21.3 %

Comparative effect of tolubutamide and plant extract of glucose oral tolerance te:

(G.T.T. in rabbit)

S.No	Substance tested orally	Effect as % of tolubutamide
1.	Tolubutamide	100
2.	Cephalendra indica	
	Alcoholic extract	6.3
	Water extract	7.9
3.	Jasminum officinale	
	Alcoholic extract	38.3
	Water extract	15.75
4.	Curcuma longa	
	Alcoholic extract	41.78
	Water extract	19.45
5.	Tinospora cardifolia	
	Alcoholic extract	12.68
	Water extract	3.46
6.	Aegle marmelos	
	Alcoholic	7.06
	Water extract	0.18
7.	Sonchus arvensis	
	Alcoholic extract	29.92
	Water extract	18.03
8.	Vinca rosea	
	Alcoholic extract	17.3
	Water extract	11.15
9.	Musa paradisiaca	
	Alcoholic extract	14.17
	Water extract	4.0
10.	Ficus bengalensis	
	Alcoholic extract	60.23
	Water extract	38.5
11.	Helecteres isora	
	Alcoholic extract	24.0
	Water extract	12.6
12.	Syzygium cumini	
	Alcoholic extract	49.0
	Water extract	26.4
13.	Phyllanthus niruri	
	Alcoholic extract	57.0
	Water extract	18.35

Annex - 7.

A NOTE ON IMPORTANCE OF FERMENTATION TECHNOLOGY

Introduction

Fermentation technology is concerned with the utilisation of microorganisms to produce metabolic intermediates orfinal products having industrial uses and applications.

Justifications

1. The fermentation processes are cheap, fast and efficient, require a limited space, energy and raw materials.
2. Basic raw materials used are sugar, molasses, oil cakes, forest and agricultural waste biomass which are available in Nepal in abundant quantity.
3. Using these simple and cheap raw materials a number of very useful drugs such as antibiotcs & vitamins, other Chemicals can be produced.
4. Fermentation processes are also used for a number of industrial microbiological conversion processes such as those needed for production of steroids. Hence a need of fermentation technology base to be created in the country to subsidise the import of drugs and chemicals.
5. Fermentation processes will play a major role in emerging biotechnology based industrial production.

Use of Fermentation Technology in the context of Nepal.

1. Establishment of fermentation industries in Nepal will help to make the country self-sufficient in life saving drugs and other chemicals.
2. Fermentation industries are socio-economically useful for a country like Nepal.

3. Nepal can minimise the international trade defecit by exporting the surplus drugs and chemicals, therefore, fermentation industries will help the country to boost up the national economy by providing the import substitution and side by side by exporting surplus products to other countries.

4. Fermentation industries being based upon domestic resources, and markets for the products being easily available at the national and international level there is little doubt about the usefulness of these industries from the economic point of view.

Laboratory scale fermenter

A Gallenkamp modular fermenter was used to carry out fermentation process in laboratory scale. On trial experiments the equipment was found to function satisfactorily.

Future Programmes

- To develop suitable technology in laboratory scale for high yielding cum quality production of antibiotics, vitamins, steroids, enzymes, amino acids etc.

- To develop techniques for the production of corticosteroids from diosgenin in laboratory scale.

- To develop techniques for the production of various medicinal products in pilot scale by utilising the fermentation technology.

.../...

- To search out new basic raw - materials and new products in fermentation technology by utilising natural resources as well as synthetic and semisynthetic materials.

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Mrs. Kamala Risal
Miss. Rohini Shrestha
Mr. S.K. Adhikary
Mr. Sunil Kumar Sharma
Mr. M.B. Narasimha - UNIDO Expert.

Annex - 8 .

Scientific Talk programmes held at RDRL

Sl. No.	Name of the Speaker	Date	Title
1.	Mr. D.D. Bhattarai	Shrawan 3,043 (18 July 1986)	Role of reference standard in QC.
2.	Dr. S.R. Adhikary	Shrawan 17,043 (1 August 1986)	Scope for the development of essential oil Industry in Nepal.
3.	Ms. Rita Basnyat	Shrawan 31,043 (15 August 1986)	Standardization of Shilajeet.
4.	Mr. A.D. Shrestha	Bhadra 13,043 (29 August 1986	An introduction to Pilot plant unit of RDRL.
5.	Dr. T. Shrestha	Bhadra 27,043 (12 Sept. 1986)	Aconites of Nepal.
6.	Mrs Sumitra Singh	Aswin 10,043 (26 Sept. 1986)	Extraction of L-Dopa from Mucuna preireta.
7.	Mr. Purna Man Shakya	Kartik 14,043 (31 October 1986)	Microbiology past and present.
8.	Mrs. Hari Devi Shrestha	Kartik 28,043 (14 Nov. 1986)	Estimation of Vitamins (water soluble) by HPLC
9.	Mr. Navin Shrestha	Mangsir 13,043 (28 Nov.1986)	Distillation technique of essential oil.

Sl. No.	Name of the Speaker	Date	Title
10.	Dr. A. Rajbhandary	Mangsir 27,043 (12 December 1986)	Extraction and isolation of Asiaticoside.
11.	Mr. B.B. Thapa	Poush 11,043 (26 December 1986)	R.D.R.L as Q.C. Lab.
12.	Mr. L.K. Vaidya	Poush 25,043 (9January 1987)	Activities of Public analysis and pyrethrum analysis.
13.	Mr. B.R. Shakya	Magh 9,043 (23 January 1987)	Transformation of Diosgenin to steroid hormones.
14.	Mrs. Ramila Joshi	Magh 23,043 (6 February 1987)	Synthetic studies in Lophotoxin.
15.	Mrs. T.K. Rajbhandary	Falgun 8,043 (20 February 1987)	Pharmacognositical evaluation of herbs and drugs used in Ayurvedic medicine.
16.	Mr. S.K. Joshi	Falgun 22,043 (6 March 1987)	Preliminary investigation of medicinal plants.
17.	Mr. P.P. Bista	Mangsir 24,044 (10 December 1987)	A feasibility study on isolation of Raubasin.
18.	Ms. P. Manandhar	Poush 9,044 (24 December 1987)	Hypoglycaemic effects of some medicinal plants of Nepal.

Sl. No.	Name of the Speaker	Date	Title
19.	Mr. Y.N. Shukla	Poush 23,044 (7 January 1988)	Rosin & Turpentine - useful materials for various Industri.
20.	Ms. S.P. Upadhyaya	Magh 21,044 (4 February 1988)	Essential oil and its uses.
21.	Ms. T. M. Shrestha	Falgun 6,044 (18 February 1988)	Pharmacognostical studies on Swertia chirata
22.	Mr.B. Das	Chaitra 18,044 (31 March 1988)	Techno-economic study for production of Caffeine from tea waste.
23.	Ms. Ikuyo Okuda	Baishakh 9,045 (21 April 1988)	Effect of Cepharantine (Stephania cephalantha) on recovery from damage of normal cells and cancer cells induced by heat.
24.	Ms. Padma Prajapati	Baishakh 23,045	Extraction of diosgenin from Dioscorea tubers.

"orkshop on " Spectroscopic methods in Natural Products Chemistry" April 22-26, 1987 organised by Nepal Chemical Society in collaboration with Royal Drug Research Laboratory, DMP and RECAST, T.U.

Annex - 9 .

List of Publication:-

1. Medicinal Plants of Nepal (Supplement) as Bulletin of the Department of Medicinal Plants No. 10,1984.

2. S.R. Adhikary and B.P. Bashyal. Aromatic Plants of Nepal Part IV: Essential Oil from Gaultheria fragrantissima Wall. J. Nep. Pharm. Assoc. 1985, 12, 9-19

3. S.R. Adhikary and B.B. Thapa: Ultraviolet Spectrophotometric Determination of Chloramphenicol and Tetracycline Hydrochloride in Pharmaceutical Preparation, J.Nep. Pharm. Assoc., 1984 11, 29-38.

4. B.B. Thapa: Pharmacognostical and Chromatographic Studies on Adhatoda vasica Nees. J. Nep. Pharm. Assoc., 1985,12, 21-26.

5. Asha Karki and S.B. Rajbhandary: Clonal Propogation of Crysanthemum cinerariaefolium Vis. (Pyrethrum) through Tissue Culture: Pyrethrum Post 1984, 15 118-121.

6. B.P. Acharya: Handling of Chemical Strucutral Information by a Computer: J. Nep. Pharm. Assoc. 1984, 11, 13-18

7. Reeta Basnyat, B.B. Thapa and S.R. Adhikary: Standardisation of Shilajeet. Chemistry Symposium organised by Nepal Chemical Society, Kathmandu, April 2, 1985.

8. B. B. Thapa, D.M. Shakya and S.R. Adhikary: High Performance Liquid Chromatographic Method of Estimation of Vascicine and Vasicinone in Pharmaceutical Preparations. Chemistry Symposium organised by Nepal Chemical Society, Kathmandu, April 2, 1985.

9. Flora of Kathmandu Valley as Bulletin of the Department of Medicinal Plants No. 11, 1986.

10. H.K. Saiju: Genetic resources of Temperate fruits in Nepal. Fourteenth International Congress, West Berlin, 14th July - 1st August 1987.

11. B.P. Acharya:" Some computer aided techniques in the Interpretation of a complex H-NMR spectra of simple organic compounds. " Chemical symposium organised by Nepal Chemical Society, April 13, 1987.

12. T.K. Rajbhandary and T.M. Shrestha: Anatomical studies on some commercially important Aconites of Nepal. J.N.P.A, 1986, 13, 15-20.

13. S.R. Adhikary, N.P. Manandhar and L.K. Vaidya: A note on availability, trade practices and quality assessment of the fruits of Zanthoxylum alatum. J. N.P.A. 1986, 13, 15-20.

14. S.R. Adhikary and J. Karlsen: Aromatic Plants of Nepal Part VI. G.C. - M.S. analysis of the essential oil of Zanthoxylum alatum fruits. J. Nep. Chem. Soc., 1987, 5-7, 24-28.

15. B.P. Acharya: A programme to calculate theoretical H-NMR spectra in a personal compter. J. Nep. Chem. Soc., 1987, 5-7, 33-36.

16. S.B. Malla and S.R. Adhikary Studies on Some essential oils in Nepal: VIII Seminar on " Fragrance and Flavour Industry- A Leap into the Future." New Delhi, January 24 - 25, 1987.

17. S.R. Adhikary: Cultivation, Processing and Marketing of medicinal and aromatic plants of Nepal. SAARC workshop on cultivation and Processing of Medicinal and aromatic Plants, CIMAP, Lucknow, 9-12 February 1988.

18. S.R. Adhikary: Some experiences in utilisation of natural products. Regional Sympsium on . High Altitude Natural Products Chemistry Kathmandu March 17 - 19, 1987.

19. Timila Shrestha: Phytochemical evaluation of a traditionally used Aconite (Aconitum spicatum Stapt.) from Nepal Himalayas. Regional Symposium on High Altitude Natural Products Chemistry Kathmandu, March 17-19, 1987.

20. Timila Shrestha: Chemical Studies on Aconites of Nepal. Third International Symposium and Pakistan - U.S. Binational Workshop on Natural Products Chemistry 9 - 14. January 1988., Karachi, Pakistan.

21. Karki, A. and S.B. Rajbhandary (1984). clonal propagation of Chrysanthemum cinerariaefolium vis. (Pyrethrum) through tissue culture. Pyrethrum Post, 15: 118-21.

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1. Mahesh K. Adhikary: Some higher fungi from Langtang and its adjoining areas.

2. Mahesh K. Adhikary: The rust fungi from Kathmandu Valley and its adjoining areas.

3. Mahesh. K. Adhikary and Vidya Manandhar: Three agarics new to Nepal.

4. Pradeep. M. Adhikary and Pradha Manandhar: Studies on the antidiabetic effects of some indigenous plants reported to be efficacous in the traditional medical system in Nepal.

5. S.R. Adhikary and B.S. Tuladhar: Essential oil from the fruits of Persea species.

6. S.R. Adhikary, Sarad Amatya and Amriteswori Rajbhandari: Phytochemical investigation of Centella asiatica.

7. Nirmal K. Bhattarai: Notes on some common home remedies of botanical origin in Kathmandu valley.

8. Nirmal K. Bhattarai: An ethnobotanical exploration in Karnali Zone.

9. Sushila Bhattarai and S.B. Malla: Karymorphological studies on two species of Paphiopedilum (Orchidaceae).

10. Sajan Dahal and Pushpa Ratna Shakya: A glimpse of Orchid flora of Nepal.

11. Vidya Laximi Gurung: Threatened and extinct ferns of Nepal Himalaya.

12. Vidya Laxmi Gurung and Rose Shrestha: A study on ecology of Eusporangiate ferns of Nepal Himalaya.

13. Damodar P. Joshi: The climate of Tarai and inner tarai of Nepal: A bioclimatic analysis.

14. Lajmina Joshi: Branch wood anatomy of Some Nepalese Ficus.

15. Lajmina Joshi: Anatomical studies of Myrica esculenta.

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17. S.K. Joshi: Preliminany pharmacological insestigation of medicinal plants.

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19. Ambika Manandhar Sanyukta Rajbhandary, Pramila Shrestha, and S.B. Rajbhandary: Micropropagation of Potato cCultivars and their field performance.

20. Radha Niraula and S.B. Rajbhandari: In vitro propagation of Citrus.

21. Neera Pradhan and S.B. Rajbhandary: Micropropagation of Brassica Oleracea, var. capitata, through cotyledonary culture.

22. Neera Phadhan: Traditional tannig technique in Nepal.

23. Tara Keshari Rajbhandri: Pharmacognostical evaluation of crude herbs and drugs used in Ayurvedic medicine.

24. S.B. Rajbhandary: Plant tissue culture method of propagation and its potential.

25. S.B. Rajbhandary and Meera Shrestha: Meristem culture of Cymbidium giganteum wall. ex Lindl.

26. P.M. Sakya: Preliminary Studies on some medicinal plants and essential oils for antimicrobial activities.

27. P.R. Shakya, D.M. Bajracharya, R.M. Joshi and T.B. Shrestha: Angiospermic plants originally described from Nepal.

28. P.R. Shakya and Krishna Bhakta Maharjan: On the study of the Cyperaceae of western Nepal.

29. P.R. Shakya and N. P andey: On the study of the family Gentianaceae in Nepal.

30. P.R. Shakya: Human influence on natural vegetation in eastern Nepal.

31. Shanti Shakya and P.R. Shakya: A study of pollen morphology of some plants from Kathmandu valley.

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33. M.N. Subedi and P.R. Shakya: Above ground biomass and productivity studies of Quercus semecarpiflora Sm. forest at Pulchoki (Lalitpur district.).

34. Indira Sharma: Study on tribe Anthemideae (Compositae) of Nepal.

35. Ananda Dev Shrestha: Pharmaceuticals in Health Care.

36. Geeta Shrestha and K.L. Manandhar: The Preliminary studies on growth pattern of some fungi.